IDENTIFICATION OF LEFT VENTRICULAR EJECTION FRACTION LESS THAN OR EQUAL TO 40 PERCENT BY QUANTITATIVE TROPONIN T MEASUREMENT AFTER ST ELEVATION MYOCARDIAL INFARCTION

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BONAFIDE CERTIFICATE

This is to certify that dissertation named **" IDENTIFICATION OF LEFT VENTRICULAR EJECTION FRACTION LESS THAN OR EQUAL TO 40 PERCENT BY QUANTITATIVE TROPONIN T MEASUREMENT AFTER ST ELEVATION MYOCARDIAL INFARCTION"** is a bonafide work performed by Dr. J. Jenu Santhosh, post graduate student, Department of Internal Medicine, Kilpauk Medical College, Chennai-10, under my guidance and supervision in fulfillment of regulations of the Tamilnadu Dr.M.G.R Medical University for the award of M.D. Degree Branch I (General Medicine) during the academic period from May 2010 to April 2013.

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DECLARATION

I solemnly declare that this dissertation **"IDENTIFICATION OF LEFT VENTRICULAR EJECTION FRACTION LESS THAN OR EQUAL TO 40 PERCENT BY QUANTITATIVE TROPONIN T MEASUREMENT AFTER ST ELEVATION MYOCARDIAL INFARCTION"** was prepared by me at Government Kilpauk Medical College and Hospital, Chennai, under the guidance and supervision of **Prof Dr. N. Gunasekaran M.D.,DTCD,** Director and Superintendent, Government Royapettah Hospital, Professor and HOD, Department of Internal Medicine, Kilpauk Medical College, Chennai.

This dissertation is submitted to **The Tamil Nadu Dr. M.G.R. Medical University, Chennai** in partial fulfillment of the University regulations for the award of the degree of **M.D. Branch I (General Medicine)**.

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CONTENTS

ABSTRACT

INTRODUCTION:

Myocardial infarction is a syndrome arising from injury to the myocardial tissues due to imbalance in the perfusion and demand with the major cause being coronary atherosclerosis with a superimposed coronary thrombus. When a myocardial injury occurs, various enzymes are being released in to the blood after two hours and they are detectable in the blood by various assays. Troponins can detect very small degrees of myocardial damage. Troponin T has practical advantages over CK-MB in the assessment of left ventricular ejection fraction. Its measurement directly correlates with the infarct size which is inversely proportional to the ejection fraction.

AIMS AND OBJECTIVES:

To identify left ventricular ejection fraction of less than or equal to 40percent by quantitatie Troponin T measurement after first episode of ST elevation Myocardial Infarction.

MATERIALS AND METHODS:

This study was conducted in Government Royapettah Hospital in the department of medicine between July and December 2012.Fifty consecutive patients with first attack of ST elevation of myocardial infarction were selected

and observed. Troponin T levels are measured 12 to 48 hours after admission so as to obtain its peak value. Two dimensional Echocardiography was done 3 to 4 weeks later and ejection fraction was measured. The relationship between left ventricular ejection fraction and troponinT concentration was studied using spearman's correlation coefficient.

OBSERVATION AND RESULTS:

There was a strong negative correlation between the left ventricular ejection fraction and Troponin T levels. Spearman's rank correlation coefficient was -0.874 with p values <0.0001.

CONCLUSION:

Troponin T shows a strong negative correlation with left ventricular ejection after a first episode of myocardial infarction. Its measurement is a quick, cheap, sensitive and highly specific method in identifying cardiac injury and to determine low ejection fraction <40 percent which is associated with complications.

INTRODUCTION

Myocardial infarction is a syndrome arising from injury to the myocardial tissues due to imbalance in the perfusion and demand with the major cause being coronary atherosclerosis with a superimposed coronary thrombus. When a myocardial injury occurs, various enzymes are being released in to the blood after two hours and they are detectable in the blood by various assays. Cardiac troponin T, troponin I, creatine kinase MB(CK-MB) are all important biomarkers of myocardial injury and when elevated, signify myocardial damage with good sensitivity and specificity[1,2].CK-MB has a lot of false positive values as they can be elevated in conditions associated with skeletal muscle injury. Troponin T and I are more specific than CK-MB for cardiac injury. CK-MB starts decreasing by 12 hours and at 24 hours, the sensitivity of Troponin is very high[3]. Troponins can detect very small degrees of myocardial damage. Troponin T has practical advantages over CK-MB in the assessment of left ventricular ejection fraction. Troponin T starts to rise by 3-12 hours and peaks at 12 hours from the onset of pain. However the plateau phase lasts up to 48 hours. Thus, there is a large time window for the peak value. So unlike CK-MB, multiple measurements are not needed in determining the peak value. Also its concentration is unaffected by thrombolysis after the first 12 hours. Thus its measurement directly

correlates with the infarct size which is inversely proportional to the ejection fraction.

DEMOGAPHY:

Every year 1.1 million people experience myocardial infarction in United States. Six million people were admitted for consideration of the disease and 46,000 people die of coronary artery related deaths. In UK, coronary artery disease is the most common cause of death. The average incidence of myocardial infarction in UK in the age group of 30 to 69 years is 600 per one lakh in males and 200 per one lakh in females. India is the country where most people with cardiac diseases reside. India reported most number of deaths due to CAD in 2002 and it is expected to double by the year 2015. If proper initiative is not taken in time, India will be harbouring around 62 million people with heart diseases by 2015 as compared to US which will be having only 16 million by then. The incidence of myocardial infarction in India among young is on the rise in the last three years. In western countries, CAD is considered as a disease of old. Only 23 percent of deaths occur blow the age of 70 yrs whereas in India, 52 percent of CAD deaths occur in the age group less than 70 years. This leads to loss of productive years of working. In the year 2000, an estimated 9.2 million productive years were lost in our country with expected rise to about 17.9 million by the year 2030.[94] The huge load

of patients with coronary artery disease in our subcontinent is probably due to the large population and due to the presence of cardiovascular risk factors in a large scale.

The INTERHEART study which was conducted in around 52 countries tell that the coronary risk factors like diabetes, hypertension, smoking, obesity, hyerlipidemia are more prevalent in India than any other countries. In 1990, there were 1.7 million deaths in India and it doubled by the year 2010. Studies tell that coronary artery disease manifests ten years earlier in India than any part of the world. In rural India, the percentage of people with heart disease has increased from 1-2 to 3-5 percent. In urban India, it has gone up from 2-3 to 10-11 percent. This increased prevalence in urban population is probably due to increase in stress, decreased physical activity, increased intake of high calorie diets and increased prevalence of risk factors. Studies among asian Indian people tell that almost half of the patients with myocardial infarction are in age group less than 50 years of age and 25 percent occur less than 40 years of age.

REVIEW OF LITERATURE

Atherosclerotic cardiovascular disease is the leading cause of death and disability in America. The chief risk factors are LDL,HDL, TGL, cholesterol, blood pressure, smoking, BMI[4]. Coronary circulation is unique in the way that they are perfused in diastole rather than in systole. Systolic contraction redistributes perfusion from subendocardium to subepicardium of heart and impedes the coronary arterial inflow and at the same time increasing the coronary venous outflow. During diastole, coronary arterial inflow increases with perfusion to the subendocardial layer. At the same time, coronary outflow fall.

Under normal resting conditions, the average coronary blood flow is 0.7 to 1.0 ml/min/gm and can raise up to four to five during vasodilation.[5].Coronary reserve is a phenomenon of ability to raise the coronary blood flow in response to vasodilators. In conditions like tachycardia where the diastolic time available for subendocardial perfusion is decreased and in conditions of increased preload, the maximum perfusion and coronary reserve are reduced. Coronary reserve is also reduced in conditions like elevated systolic pressure, heart rate, contraction which are determinants of oxygen consumption or in conditions which decrease arterial oxygen supply like anemia and

hypoxia. Subendocardial flow occurs mainly during diastole and starts to reduce when mean coronary pressure of 40 mmHg is reached.[6] Contrary to that, throught the cardiac cycle the subepicardial flow occurs and is maintained till the coronary pressure reaches 25mmHg. Increased oxygen consumption in subendocardium is the reason for that, which needs higher resting flow level[7].Thus subendocardial ischemia can be precipitated even in conditions where coronaries are normal. Studies have shown that the coronary autoregulation is active till the mean coronary pressure reaches 40 mmHg.(DBP 30 mmHg)

DETERMINANTS OF MYOCARDIAL OXYGEN CONSUMPTION:

Consumption of oxygen is near maximal at rest in myocardium.[8] reaching approximately 75 percent of arterial content. Because of this property, increase in coronary flow and oxygen delivery caters to the need of myocardium. Apart from coronary flow, oxygen delivery is directly determined by arterial oxygen content. Anemia results in proportional decrease in oxygen delivery. The factors which determine of myocardial oxygen consumption are blood pressure, heart rate, myocardial wall stress and LV contractility.

MAINTENANCE OF CORONARY TONE:

Normally, the epicardial arteries donot significantly contribute to the coronary vascular resistance. But their diameter is altered by a number of factors which are released from the platelets, certain neurohumoral agonists, neural tone and by local control . The substances that modulate are acetylcholine, nor epinephrine, bradykinin, histamine, substance p, endothelin, substances released by the platelets like thrombin, serotonin, adenosine-di-phosphate, thromboxane, vasodilators like adenosine, papaverine, dipyridamole and nitroglycerine. These all act through certain endothelial dependant factors such as nitric oxide, Endothelial Dependent Hyperpolarising Factor (EDHF), prostacyclin, endothelin.

NITRIC OXIDE:

It is produced by the endothelium in the process of conversion of L-arginine to citrulline mediated by nitric oxide synthase. The nitric oxide binds to guanyl cyclase,thus increasing cGMP production and decreasing intracellular calcium thus producing vascular relaxation. Vasodilation mediated by nitric oxide is enhanced by changes in coronary shear stress. This vasodilation is impaired in many diseases and in patients with more than one risk factor for coronary artery disease .This is

by superoxide anion generated as a result of oxidative stress which inactivates the vasodilator nitric oxide. This is seen in conditions like atherosclerosis , hypertension, diabetes mellitus.

Endothelial Derived Hyperpolarising Factor:

Endothelial Derived Hyperpolarising Factor is supposed to be a metabolite of arachadonic acid metabolism and is produced by the endothelium. This substance hyperpolarises vascular smooth muscle and opens the calcium activated potassium channels thereby dilating arteries. It is through EDHF, agents like bradykinin as well as shear stress induced vasodilation acts.

Prostacyclin:

It is a product of metabolism of arachdonic acid through cyclooxygenase. It is a coronary vasodilator. Vasodilatory prostaglandins are very important determinant of collateral vessel tone rather than of native vessels and studies have proven that.

Endothelin:

ET1, ET2, ET3 are endothelium dependent constricting factors. ET1 is a potent constrictor and has prolonged action. The effects of endothelin are mediated through ET receptors. Endothelin is not involved

in regulating normal heart but it can alter the vascular tone in conditions like heart failure where its level rises.

DETERMINANTS OF CORONARY VASCULAR RESISTANCE:

Resistance to the flow of coronary blood has three major components. First is by the epicardial coronary artery. Under normal conditions, negligible resistance is noted in these vessels. The second component is due to the microcirculatory resistance arteries and arterioles within the myocardium. Third component is due to the contraction of heart and due to the systolic pressure development within the left ventricle. The compressive effects are prominent in the subendocardium.

MYOGENIC REGULATION:

Ability of the vascular smooth muscle to which opposes changes in coronary arteriolar diameter is called myogenic regulation. Thus vessels relax when the distending pressure is elevated. Myogenic tone is a property of vascular smooth muscles in animals and humans [9,10] . It depends on the vascular smooth muscle calcium entry. It brings back local coronary flow back to original level. It occurs chiefly in arterioles less than 100mm.

SYMPATHETIC INNERVATIONS:

Under normal conditions, there is no resting sympathetic tone. During sympathetic activation, the tone of coronaries is moulated by norepinephrine which is released from the sympathetic nerve endings along with the circulating epinephrine and norepinephrine. Sympathetic stimulation leads to α1 mediated constriction and vasodilation mediated by β2 receptors. The final effect is to dilate the epicardial coronary arteries. When the coronary dilation mediated by nitric oxide is impaired, the vasoconstriction mediated by α1receptors predominate and can increase the severity of stenosis. Summarising, β1 increases the myocardial oxygen consumption.α1 mediates coronary constriction and β 2 mediates coronary vasodilation. In normal conditions, β2 mediated dilation predominates.

CORONARY VASOSPASM:

It causes transient functional blockage of coronary artery. It is usually reversed by nitrates. In coronary artery disease, it is the endothelial disruption which plays an important role in causing focal vasospasm. Here, the normal vasodilation by the autocoids and the sympathetic stimulation is converted in to a vasoconstrictor response. This is due to the lack of endothelium dependent vasodilation. In

conditions like prinzmetal's angina there is sensitization to vasoconstrictor mechanisms. A protein called Rho which binds GTP can sensitize the vascular smooth muscle to calcium by inhibiting myosin phosphatase activity through a protein called Rho kinase.

Physiology of Right Coronary Blood Supply:

There are differences in the right coronary supply to the RV free wall compared to the left ventricle. The arterial pressure which supplies the right coronary exceeds the right ventricular pressure. This decreases the compressive factors of coronary reserve. The right ventricular oxygen consumption is also lower than the left ventricle. The oxygen saturations of the right coronary veins are higher than in the left coronary circulation.

CORONARIES-ANATOMY:

Right and left coronaries arise from ascending aorta from its anterior and posterior sinuses. They usually arise above the cuspal margins. The main artery and the main branches are usually subepicardial. "Dominance" is the term used to refer to the coronary artery that gives rise to posterior interventricular branch. This artery supplies posterior part of ventricular septum and part of posterolateral wall of left ventricle. In most of the cases, left coronary is the dominant artery. The right and left coronaries anastamose abundantly during fetal

life but by the and of first year, they are reduced. The diameter of coronary arteries range from 1.5 to 5.5mm at the origin. Normally, the left coronary is larger than the right coronary.

Right coronary artery:

It arises from the anterior aortic sinus. It is usually single. It reaches the atrioventricular groove and runs vertically to the right cardiac border. It anastamoses with the circumflex branch of left coronary artery. The first branch is the Arteria Coni Arteriosi or the Conus artery. It is sometimes called the third coronary artery. It anastamoses with its counterpart from left side and forms annulus of vieusssens- an anastamotic circle around the pulmonary trunk. The other branches are atrial (anterior, lateral and posterior groups) , artery of sinuatrial node (sometimes from the circumflex branch of left coronary), septal branches (from posterior inter ventricular artery). The largest posterior septal artery usually supplies atrio ventricular node.

Left coronary artery:

It is larger than right coronary artery. Supplies almost whole of left ventricle and atrium. It arises from left posterior aortic sinus. Left coronary supplies most of interventricular septum. It has two or three main main branches- the notable ones are anterior interventricular artery

and circumflex artery. The anterior interventricular artery produces right and left anterior ventricular and anterior septal branches. The circumflex artery continues as posterior descending artery in some. In 90% of people, a large ventricular branch, the left marginal artery arises perpendicularly from circumflex artery and ramifies over the rounded obtuse margin.

It is the coronary pressure distal to the stenosis which determines the maximum myocardial perfusion. Because of the property of autoregulation, the flow remains the same even if the stenosis increases in severity. Because of coronarary reserve, flow can increase 5 times than the resting flow values. Until the stenosis reaches 50%, the epicardial artery resistance increases very little. So there is no pressure drop across stenosis until stenosis exceeds 50%. As the severity of the stenosis increases, the pressure drop across stenosis occurs. This pressure drop decreases the distal coronary pressure which is the major determinant of perfusion to microcirculation. Above 70% of diameter reduction, even small increase in severity of stenosis causes large increase in stenosis pressure drop and decrease in distal coronary pressure and large decrease in maximum vasodilated perfusion of microcirculation. If the stenosis is more than 90 percent which is called as critical stenosis, vasodilation of the subepicardial vessels with drugs cause further decrease in distal

coronary pressure. This causes reduction in subendocardial flow leading on to transmural steal phenomenon.

CONSEQUENCES OF ISCHEMIA:

Sudden stoppage of flow following a coronary occlusion causes the aerobic metabolism to an end and depletes creatine phosphokinase. This directs the cellular metabolism towards anaerobic glycolysis, leading on to lactate accumulation and decrease in ATP levels. With continuing ischemia, acidosis develops and thereby causing potassium efflux in to extracellular space. Myocyte death follows as the levels of ATP fall below which is needed to maintain membrane function.

The extent of injury after occlusion depends on residual blood flow in coronaries, the location of block, and the factors which determine the oxygen consumption. Injury starts within 20 minutes after the occlusion in the absence of collaterals.[11] Irreversible injury starts initially at subendocardial region and proceeds to subepicardial region. This suggests higher oxygen consumption in the subendocardial layer. In experimental cases, the entire subendocardium is injured irreversibly within one hour of occlusion. Prior repeated attacks of reversible ischemia or angina before an episode of occlusion can reduce the irreversible injury through preconditioning. [12]

Residual coronary flow which occurs through the occluded artery is the determinant of time taken for irreversible injury to occur. The size of the infarcted myocardium and area which is at risk of ischemia during the period of total occlusion depends on the collateral flow. When the subendocardial collateral flow is greater than 30 percent of resting flow values, occurrence of infarction is prevented for more than one hour. Subtotal occlusion can for atleast 5 hour without producing significant irreversible injury[13]. Cell death arises by two mechanisms. The first mechanism is by reperfusion injury where the reperfusion leads to necrosis of myocytes with disruption of sarcolemma causing leakage of the cellular contents. The injury is further increased by the influx of leucocytes to the injured area. The other mechanism of cell death is by apoptosis.

Myocardial pre and post conditioning: reversible ischemia occurring before a prolonged coronary occlusion produces necrosis of myocytes a term called acute preconditioning.[12,14] it delays the irreversible myocardial injury. Pharmacologic preconditioning is achieved by activation of adenosine A1 receptor activation, by drugs causing protein C or open K^+ ATPase activation. On a chronic basis also preconditioning can develop (delayed preconditioning) and, it can persist till 4 days if induced.[15]. Preconditioning protects the heart from

ischemia-induced stunning and reduces size of infarct. The mechanisms involved are synthesis of proteins, upregulation of the inducible form of NO synthase, cyclooxygenase, and mitochondrial K^+-ATP channel opening. Myocardial postconditioning is a final protective mechanism. This protects the heart by producing ischemia intermittently or by administering drugs at the time of reperfusion. It has a capability to affect irreversible injury because it can be induced after myocardial ischemia is established rather than requiring pre-treatment.[12]

DIAGNOSIS - Chest pain :

The decision whether to admit the patient in coronary care setting , in observation ward, to discharge him home all depends upon careful history, physical examination, electrocardiogram, and in those suspected of ACS, biomarkers. The factors suggesting high likelihood of having ACS and risk of short term complications include prolonged or accelerating ischemic symptoms, evidence of congestive cardiac failure, ECG abnormalities that are not told to be old, and elevated markers of myocardial injury[16,17]

History:

A history of myocardial infarction is associated with high risk of obstructive coronary disease but also increased likelihood of multivessel

disease. Women with suspected ACS have less chances of epicardial coronary artery disease than men of same age and similar clinical presentation. If present, it is of less severity[18,19]. Beyond the age of 70 years, risk of coronary artery disease and adverse outcome increases.[20] History regarding diabetes can help identify high risk patients among those with ACS.[21,22]. ACC/AHA guidelines suggests, the risk factor data should not be used to determine whether the patient should be admitted or not.[23] . Also the family history regarding coronary heart disease is not a useful indicator in the diagnosis or prognosis of the patients with chest pain.

Physical examination:

Initial examination should focus on the precipitating factors (e.g hypertension), comorbid conditions (eg COPD), evidence of complications like CCF, hypotension, new onset mitral regurgitation.[23]. Also a look in to the peripheral vessels for the presence of bruit, absence of pulses should be made which suggests extracardiac vascular disease. If the clinical presentation does not suggest it is of cardiac origin, the search for noncoronary cause should be made. It includes first the life threatening conditions like aortic dissection, pulmonary embolism and then in to other causes like pericarditis or esophageal discomfort. Aortic

dissection is suggested by disparities in blood pressure or pulses or a new murmur of aortic regurgitation accompanied by back or midline anterior chest pain. Pulmonary embolism manifests as tachycardia, tachypnea, and a loud component of second heart sound. Pneumothorax manifests with differences in breath sounds and dyspnea.

Electrocardiogram:

An electrocardiogram provides valuable information regarding the diagnosis and prognosis. [16, 17]. New onset persistent or transient ST segment abnormalities (>0.05mV) which develop during an episode and resolve after the symptoms resolve strongly suggests acute ischemia and severe coronary disease. Any lesser amount of ST segment deviation or T wave inversion of less than or equal to 0.3 mV are called non specific changes. A completely normal ECG does not rule out the possibility of acute coronary syndrome. One to six percent of such patients evolve in to acute MI and up to 15 percent have unstable angina. Yet these patients have better prognosis than those who presented with ECG changes.[17,24]. A prior ECG improves the diagnosis acute myocardial infarction if combined with serial measurement of biomarkers.[25]

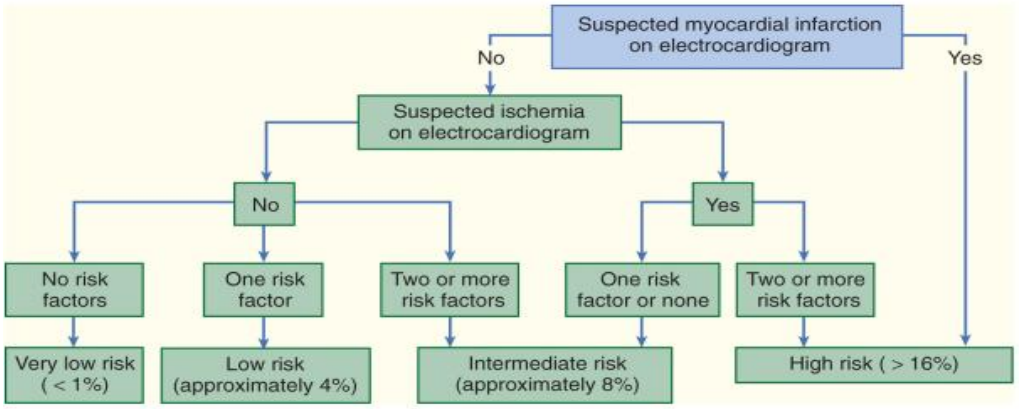


Fig:1 Categorization of patients according to major cardiac events within 72 hours of admission[28].

History, physical examination, 12 led ECG, cardiac markers all help in assigning patients to four categories- non cardiac chest pain, chronic stable angina, possible ACS, definite ACS[23] patients with ST elevation are triaged immediately for reperfusion therapy. Patients with ST and T wave changes ,ongoing chest pain, positive cardiac markers or with hemodynamic abnormalities should be admitted in hospital for management of ischemia. For patients with possible or definite ACS who do not have definite ECGs or whose cardiac markers are normal initially are advised admission in a chest pain unit. Patients with low risk can be observed for 4 to 8 hours while undergoing ECG monitoring and serial measurement of cardiac markers. Patients who develop signs of ischemia are admitted to the coronary care unit (fig:1)

Early noninvasive testing:

The low risk patients should be subjected to stress testing to know their performance status. Treadmill exercise electrocardiography is an inexpensive test that is available in any centers. They provide reliable prognostic information of low risk patients. Bruce or modified Bruce protocol is used. One study found that the patients with low risk who had negative stress test had less recurrence of events than those with positive or equivocal test at the end of 6 months[26]. Bruce or modified Bruce treadmill protocol is used for exercise testing. Studies have shown that patients who have low clinical risk of complications can safely undergo exercise testing within 6 to 12 hours after presentation to hospital.[27] Immediate stress testing should not be done for patients with electrocardigraphic findings consistent with ischemia not known to be old, ongoing chest pain or evidence of congestive cardiac failure.

The indications for exercise stress testing are the following-

1. Two sets of cardiac enzymes at 4 hourly intervals should be normal.

2. ECG at the time of presentation and pre exercise 12 lead ECG shows no significant abnormality.

3. Absence of rest abnormalities,

4. Lessening chest pain symptoms or persistent atypical symptoms,

5. Absence of ischemic chest pain at the time of exercise testing.

The contraindications for stress testing are

1. New or evolving ECG abnormalities on rest tracing,

2. Abnormal cardiac enzymes, inability to perform exercise,

3. Worsening symptoms,

4. Indications for coronary angiography is likely.

Imaging tests:

Stress ECHO cardiogram or radionucleotide scans are the preferred non invasive testing modalities for people who cannot undergo treadmill electrocardiographic testing because of disability. They are less readily available and more expensive than exercise electrocardiography. But are more sensitive in detecting coronary artery disease and localize and quantify the extent of jeopardised myocardium. High risk scans are associated with increased risk of major cardiac events than those with low risk scans.[29,30]. The radionucleotide scans also help to detect whether

the patients symptoms are due to ischemia. Their availability scans did not influence the management, but rather reduced the admission rates.[31]

Echocardiography can be used with or without stress to detect wall motion abnormalities which denotes myocardial ischemia.[32,33]. The presence of regional wall motion abnormalities, correlates with worse prognosis. Even with all these benefits, guidelines recommend exercise echocardiography as the preferred first-line test.

Multidetector Computerized Tomography (MDCT) has been evaluated in identifying the patients with risk for ACS. Cardiac magnetic resonance imaging is also being used in assessing the patients with suspected ACS[53]. In a study that used cardiac MRI to quantify myocardial perfusion, ventricular perfusion and hyper-enhancement in patient with chest pain, the sensitivity for ACS was 84% and the specificity was 85%. T2- weighted image adds on to the diagnosis and helps in differentiating acute from chronic perfusion defects. Stress MRI with adenosine and MRI coronary angiography are being studied. Additional studies and newer techniques are necessary to reduce radiation exposure from such testing before they are adopted widely.

ST ELEVATION MYOCARDIAL INFARCTION:

Myocardial infarction refers to myocyte cell death caused due to prolonged ischemia. Characteristic pathologic findings include coagulation necrosis and contraction band necrosis with patchy areas of myocytolysis at the periphery of the infarct. During acute phase, myocyte loss in the infarct zone is due to coagulative necrosis which then proceeds on to inflammatiom, phagocytosis of necrotic myocytes and repair leading on to scar formation. Clinical diagnosis requires history along with evidence of myocardial necrosis using biochemical, electrocardiographic and imaging modalities. The sensitivity and specificity of the tools vary depending on the time after the onset of infarction.

Revised definition classifies MI in to five types depending on the circumstances on which it occurs[34]

1. Spontaneous; this is related to ischemia caused by plaque erosion and/ or rupture, fissuring or dissection.

2. Secondary to ischemia caused by demand-supply mismatch (coronary spasm, embolism, arrhythmias, anaemia, hypertension, hypotension)

3. Sudden unexpected cardiac death, including cardiac arrest, with symptoms suggestive of myocardial ischemia, and presumably accompanied by new LBBB, or new ST-segment elevation, or a new major obstruction in a coronary artery angiographically and/or pathology, but death occurring before blood samples are taken, or before the cardiac biomarkers appear in blood.

4a. Myocardial infarction associated with primary coronary intervention (PCI)

4b. Myocardial infarction associated with stent thrombosis.

5. Myocardial infarction associated with CABG.

Criteria for acute ,Evolving or Recent MI[35]

Any one of the criteria given below fulfils the diagnosis of acute, evolving, or recent myocardial infarction:

1. Rise and fall of biochemical markers of myocardial injury with atleast one of the following:

   a. symptoms of ischemia

   b. pathologic Q wave formation in the ECG

c. Changes in the electrocardiogram consistent with ischemia (ST segment elevation or depression)

d. New loss of viable myocardium or new regional wall motion abnormality evidenced by imaging methods.

2. Evidence of acute myocardial infarction documented pathologically.

Criteria for Healing or Healed Myocardial Infarction

Any one of the following criteria needs to be fulfilled for the diagnosis of healing or healed myocardial infarction.

1. New pathologic Q waves in serial ECGs. The patient may or may not remember previous symptoms. Cardiac injury markers of may have normalised.

2. Healed or healing infarction by pathological examination

Incidence:

STEMI is a major health problem in developed nations and its impact is raising in the developing nations.[36] In United States, almost one million people suffer from acute MI and more people enter coronary care units. The rate rises for both men and women with increasing age

with blacks being more affected than the whites(fig:2). The burden of MI in developing countries approach those of developed countries. Main concern in the developing nations is the limitations in the available resources to treat MI. This mandates major effors to be undertaken at international level to strengthen primary prevention programmes[37]

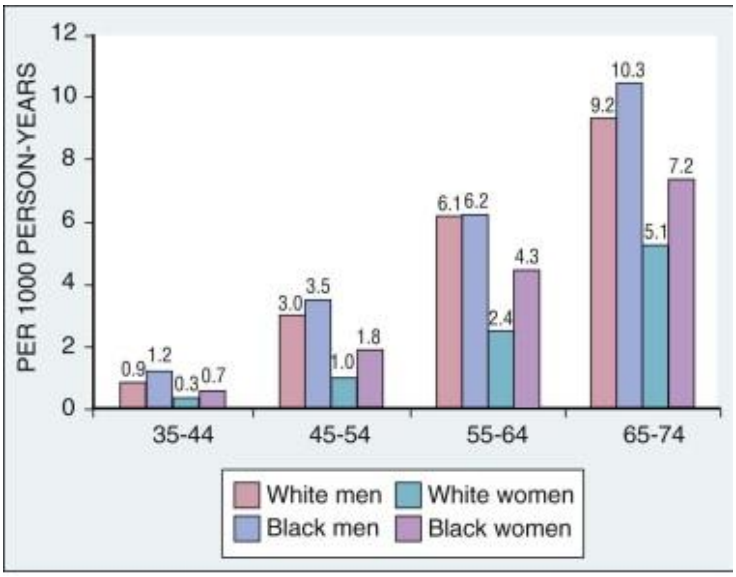


Fig 2: Annual rates of first episode of MI by age, sex and race (data, Atherosclerosis Risk in Communities [ARIC] surveillance, 1987-2004).

Mortality from STEMI has declined steadily. This is due in part to the reduction in the incidence of STEMI and secondly due to decrease in case fatality rate once STEMI has occurred. [39]. Coronary care has crossed several phases in managing patients thereby reducing the mortality. The modern era- "the reperfusion era" consists of initially

intracoronary followed by intravenous fibrinolysis, increased use of aspirin, and the development of primary percutaneous coronary intervention. Also patients' care has also moved in to an evidence based coronary therapy and is influenced by guidelines and performance measures.[40-42]

The immediate mortality rate of STEMI patients who are treated with aggressive reperfusion therapy is in the range of 6.5 to 7.5 percent[43] but studies show that the mortality is 15 to 20 percent. This is due to the fact that about 30 percent of those who develop STEMI and are eligible to receive reperfusion therapy do not receiving the life saving treatment.[44]. This is in part may also due to the selection bias.

Advanced age is one of the important determinants of mortality in patients with STEMI. Evidence suggests that reductions in the mortality in old patients with STEMI depends upon the strategies used during the first 24 hours where appropriate use of lifesaving reperfusion therapy has greater importance emphasizing the need to extend the advances in therapy for STEMI to old patients[43] . Variation exists in the management and outcomes of patients with STEMI. Mortality rates are lower in hospitals with high rate of invasive procedures. Also mortality rates are higher in STEMI patients not cared for by cardiovascular

specialists[45]. Variation also occurs in the treatment of certain subgroups with STEMI especially women and blacks. Evidence exists that much of the regional variation in outcomes derives from the characteristics of the patient and treatments received as opposed to the location where those treatments were delivered.

Causes of myocardial infarction other than atherosclerosis[46]

Arteritis:

Luetic, granulomatous, Polyarteritis nodosa, Kawasaki disease, disseminated lupus erythematosis, Rheumatoid spondylytis, Ankylosing spondylitis,

Traumatic:

Laceration, thrombotic, radiation,

Metabolic disease:

Hurlers disease, homocystinuria, fabry's disease, amyloidosis, juvenile intimal stenosis, psedoxanthoma elasticum,

Coronary fibrosis secondary to radiation, intimal hyperplasia secondary to steroid use

Luminal narrowing by other mechanisms

Prinzmetal angina, coronary spasm after nitroglycerine withdrawl, aortic or coronary dissection.

Emboli to coronaries:

Infective endocarditis, Non bacterial thrombotic endocarditis, prolapse of mitral valve, prosthetic valve emboli, cardiac myxoma, cardiopulmonary bypass, angiography, thrombi from intra cardiac catheters and guidewires, paradoxic emboli

Congenital coronary artery anomalies:

Coronary artery from pulmonary trunk left coronary from anterior sinus of valsalva, coronary arteriovenous malformation, coronary aneurysm.

Myocardial oxygen demand supply disproportion:

Aortic stenosis, aortic insufficieny, carbon monoxide poisoning, thyrotoxicosis, prolonged hypotension, Takosubo cardiomyopathy.

Hematologic:

Thrombocytosis, Polycythemia vera, disseminated intravascular coagulation, hypercoagulability, thrombosis, thrombocytopenic purpura

Miscellaneous:

Cocaine abuse, coronary contusion, catheterization

Previously, the patients with MI were divided in to Q wave and non Q wave infarctions depending upon their ECG evolution over several days. The Q wave infarctions refer to transmural infarction whereas non Q wave infarctions refer to subendocardial infarctions. Studies indicate that the development of Q waves depend more on the size of infarct rather than the depth of the infarct.[47,48]. Now the term acute coronary syndrome is coined for these to avoid confusion taking in to account the pathophysiologic mechanisms involved and it seems to be more appropriate than the older terms.

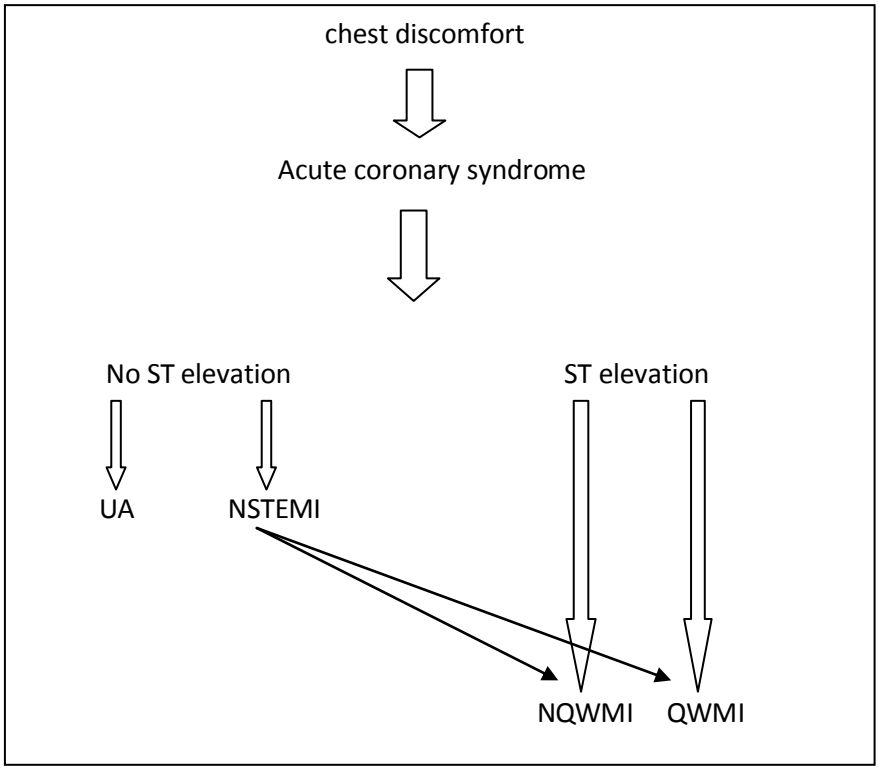


Fig3:(Flow chart depicting differentiation of patients with acute coronary syndrome in to various subtypes.)

Plaque:

During the evolution of lipid laden plaques, transition can occur in the form of plaque disruption[49,50]. Plaque disruption exposes substances that promote platelet activation and aggregation leading on to thrombin formation and ultimately thrombus formation. The thrombus thus formed leads on to oxygen supply and demand imbalance and if severe can lead on to myocardial necrosis.

Composition of plaque:

The plaques which cause total occlusion of the coronaries are more complex and irregular than those which don't cause STEMI. Histology of these plaque shows plaque rupture or erosion. The thrombus composition can vary; white thrombi consisting of platelets, fibrin, or both and the red thrombi containing erythrocytes, fibrin, platelets and leucocytes. The plaques which are prone for disruption overexpress enzymes that degrade the extracellular matrix of the plaque[51,52]. The intra-luminal pressure induced stress, coronary vasomotor tone, disruption of nutrient vessels and tachycardia combine to produce plaque disruption at the shoulder of the plaque. Number of physiological variables such as blood pressure, heart rate, blood viscosity, t-PA activity, PAI-1 levels, cortisol and epinephrine show a circadian rhythm and seasonal variation and increase

at the time of stress. This is the reason for STEMI occurring in the early hours of morning especially in winter and after natural disasters[53]

Acute coronary syndromes:

Plaque disruption exposes the thrombogenic substance that produces thrombus. In the absence of collaterals, completely occluded thrombi produce transmural injury of ventricular wall leading on to ST elevation in ECG. Infarction alters the depolarisation which is reflected as changes in QRS complex. The formation of Q waves is more characteristic of patients with STEMI and hence designated as Q wave myocardial infarction[54]. In a small subset of patients, diminution of R waves or notching of QRS is seen. Patients without ST segment elevation are termed as having unstable angina or NSTEMI. The patients with STEMI are candidates for reperfusion therapy either pharmacologic or catheter based. All patients with acute coronary syndrome should receive anticoagulant therapy and anti platelet therapy regardless of the type.

GROSS PATHOLOGY:

Coagulation necrosis:

It is due to severe persistent ischemia. The central region of infarct shows features of coagulative necrosis. Muscle cells are arrested in the relaxed state. Stretching of myofibrils, with nuclear pyknosis, vascular

congestion, healing by phagocytosis are seen. Mitochondrial damage is present but without calcifications.

Necrosis with contraction bands:

It is also called as contraction band necrosis or coagulative myocytolysis. Ischemia followed by reflow may cause this type of necrosis [35]. Mitochondrial injury is present with calcification. It is caused due to the entry of calcium in to the dying cells causing arrest of cells in the contracted state. This occurs in the periphery of large infarcts and is associated more with the nontransmural than the transmural infarctions.

Myocytolysis:

Ischemia without necrosis if severe and prolonged can cause myocyte vacuolization termed as myocytolysis.

Electron microscopy:

Within 20 minutes of complete occlusion of coronaries, glycogen granules reduce in number and size, intra cellular edema develops and transverse tubular system and mitochondria become distorted. These are reversible. After 60 minutes of occlusion, several changes occur in the myocyte in the form of swelling, disruption of mitochondria, margination of nuclear chromatin, amorphous aggregation, and relaxation of myofibrils.

Apoptosis:

Otherwise called as programmed cell death, apoptosis is an additional pathway of myocyte death. The myocytes show shrinkage of cell, fragmentation of DNA and phagocytosis without infiltrates. Major impact of apoptosis appears to be on late myocyte loss and ventricular remodelling after MI.

Modification of pathologic changes by reperfusion:

If reperfusion occurs earlier,(within 15 to 20 minutes) necrosis can be prevented.(fig:4) Beyond this period, the number of salvaged myocytes relates directly to the length of the coronary occlusion. Reperfused infarcts show mixture of necrosis, haemorrhage, coagulative necrosis with contraction bands and distorted architecture of the cells. In reperfusion, early peaking of substances like CKMB and cardiac specific troponin T and I are seen. This is due to the accelerated washout of intracellular proteins.

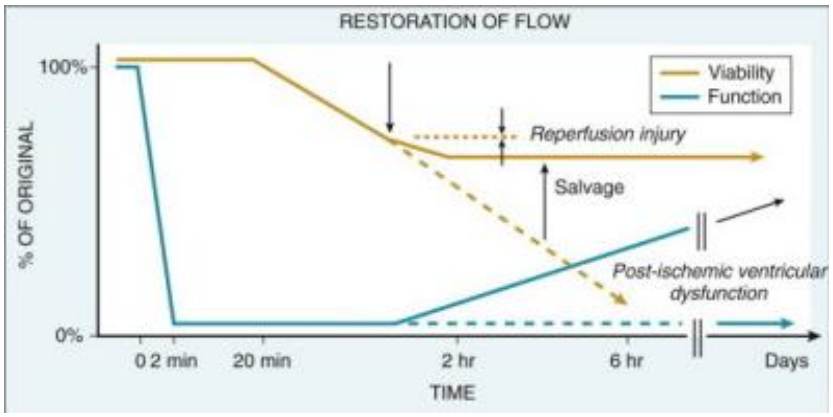


Fig:4 (consequences of occlusion of coronaries and the effects of reperfusion)

Right Ventricularmyocardial Infarction (RVMI):

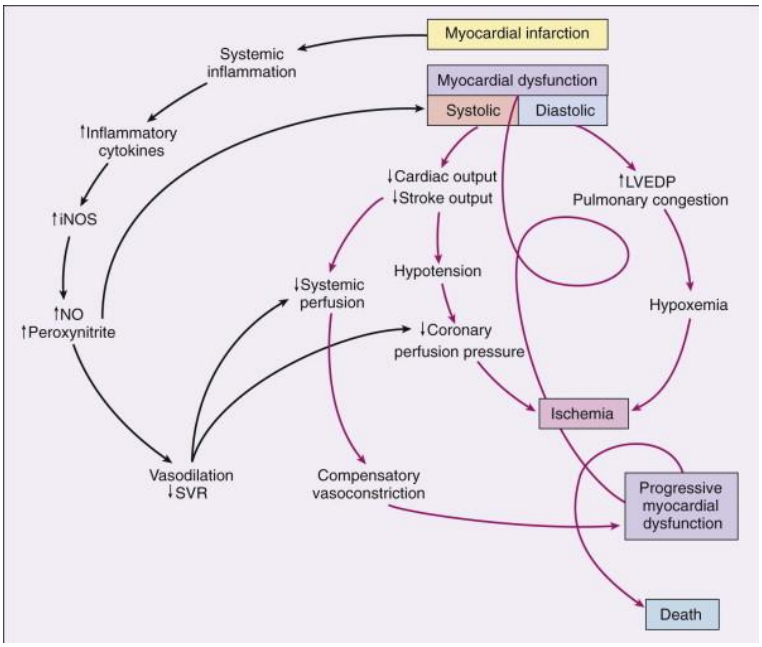
In about half of the patients with inferior wall infarction, some involvement of the right ventricular wall is seen.[41]It occurs in those with transmural infarction of inferoposterior wall and posterior portion of the septum. RVMI is usually associated with infarction of the adjacent septum and inferior left ventricular walls. In about 3 to 5 percent of cases, isolated involvement of right ventricle is seen. The right ventricle has the ability to withstand long periods of ischemia and to recover its contractile function after it is being reperfused.[57]

Atrial infarction:

It is seen in about 10 percent of patients with STEMI. It often occurs with the ventricular infarction. And can cause atrial wall rupture. More commonly seen on the right side than the left side, this type of infarctions more frequently involve the atrial appendages. They are frequently accompanied by atrial arrhythmias[44]

Abnormality in circulatory regulation is seen in patients with STEMI. It all begins with the anatomic or functional obstruction resulting in myocardial ischemia and if persistent, leading on to infarction and can depress in the left ventricular function leading on to fall in stroke volume

and rise in filling pressure. This decreases the aortic pressure and reduces the coronary perfusion pressure thereby producing a vicious cycle.



(Fig:5 showing the events following an episode of myocardial infarction)

Dilation of the ventricle:

Ventricular remodelling is also caused by dilation of the viable portion of the ventricle although infarct expansion plays an important role. It starts immediately after an episode of STEMI and progresses months or years thereafter. It is a compensatory mechanism through which the heart maintains the stroke volume. In due course of time, compensatory hypertrophy can occur. This is the reason for hemodynamic improvement in patients with STEMI after months.

Effects of treatment:

Ventricular remodelling is affected by factors like infarct size, scar formation after infarct, Reperfusion and other measures restrict the extent of myocardial necrosis and thus increase the stroke volume after MI. glucocorticoids and NSAIDS can cause scar thinning and increase in the infarct size. Blockers of RAAS attenuate the ventricular enlargement, decrease the endothelial dysfunction and has got antiatherogenic effects. Aldosterone blockade reduces the collagen deposition and decrease the development of ventricular arrhythmias.[57]

Clinical features:

Patients with STEMI appear anxious. An anguished facial expression is seen which is not usually seen in patients with angina. Some may be restless and move about in an attempt to find a comfortable position. They often clutch or massage their chests and describe their pain with clenched fist against the sternum(the Levine sign). Patients in left ventricular failure and sympathetic stimulation, cold perspiration and skin pallor may be seen. They sit or propped up in bed gasping for breath. They may cough out frothy, pink, or blood streaked sputum. Depending on the cerebral perfusion, the patient may speak normally or may have confusion or disorientation.

Heart rate:

It can vary from marked bradycardia to rapid regular or irregular tachycardia. Mostly thee pulse is rapid and regular in the range of 100 to 110 beats per minute which slows down as the patient's pain and anxiety are relieved

Blood pressure:

Most of the STEMI patients are normotensive although a reduced stroke volume is present. Previous normotensives show a rise in blood pressure especially in the early hours after infarction with values as high as 160/90 mmHg. This is probably due to the increased adrenergic drive secondary to pain, anxiety, and agitation. Previous hypertensives often become normotensives without treatment. In patients with massive infarction, there is acute fall of arterial blood pressure mainly because of the LV dysfunction and venous pooling secondary to administration of morphine and/or nitrates.

Patients with systolic blood pressure less than 90 mmHg with evidence of end-organ hypoperfusion are said to have cardiogenic shock. Presence of hypotension alone does not signify cardiogenic shock as some patients with inferior wall myocardial infarction have decreased blood pressure due to activation of Bezold-Jarisch reflex. This

hypotension resolves spontaneously or is accelerated by intravenous atropine (0.5 to 1 mg) or by the assumption of trendelenburg position. Some who are initially slightly hypotensive may gradually worsen with progressive reduction of the cardiac output due to increasing ischemia or extension of the infarction. Initially, more than 50 percent of the patients with inferior STEMI have evidence of excess parasympathetic activity with hypotension, bradycardia or both. In contrast to that, those with anterior STEMI show features of sympathetic excess with hypertension, tachycardia or both.

Temperature and respiration:

Most of the patients with STEMI develop fever as a response to tissue necrosis within 24 to 48 hours of onset of infarction. Temperature starts rising by 4 to 8 hours after the onset of infarction. It usually resolves by 4^{th} or 5^{th} day after infarction. The respiratory rate may be slightly elevated after the development of infarction. This is mainly due to the anxiety and pain and it reduces with treatment. In patients with pulmonary edema, the respiratory rate may be as high as 40 per minute. In older patients with cardiogenic shock or heart failure, Cheyne-Stokes respiration may be seen particularly after opiate therapy or in the presence of cerebrovascular disease

JVP:

The ‘a’ wave can be prominent in those with pulmonary hypertension secondary to LV failure. In patients with right ventricular infarction, the jugular venous distension can be seen with tall c-v waves of tricuspid regurgitation if there is associated necrosis of papillary muscles. In patients with STEMI who have hypotension, signs of hypoperfusion and flat neck veins, the depressed LV performance is in part to hypovolemia. The differentiation is made by using echocardiogram, or by using pulmonary artery floatation catheter.

Carotids:

A small carotid pulse suggests a reduced stroke volume whereas a brief upstroke is often seen in patients with mitral regurgitation or ruptured ventricular wall with a left to right shunt. The presence of pulsus alternans denotes severe dysfunction.

Chest:

Patients who develop LV failure present with moist rales. Diffuse wheezing can present in those with severe LV failure. Cough with hemoptysis can occur because of pulmonary embolism. Killip and Kimball proposed in 1967 proposed a prognostic classification scheme on the basis of severity of rales detected in patients with STEMI.

Killips prognostic classification in patients with STEMI:

Class I : No rales; no third heart sound

Class II : Presence of rales but to a mild to moderate degree (<50% of lung fields); third heart sound may or may not be present

Class III : Presence of rales more than half of lung field and frequently have pulmonary edema.

Class IV : Presence of cardiogenic shock.

CARDIAC EXAMINATION:

Palpation: Usually the palpation of the precordium may yield normal findings. There may be presence of third or fourth heart sound.

Auscultation: The heart sounds, particularly the first heart sound is muffled and inaudible immediately after the infarct. And their intensity frequently increases in convalescence. A soft first heart sound may also reflect prolongation of PR interval. Patients with marked ventricular dysfunction and/or left bundle branch block may have paradoxical split of second heart sound. A fourth heart sound is almost universally present in patients in sinus rhythm with STEMI. However it is audible in most patients with chronic ischemic heart disease.

A third heart sound in patients with STEMI reflects severe LV dysfunction. It is caused due to the rapid deceleration of transmitral blood flow during protodiastolic filling of the left ventricle. This is best heard at the apex with the patient in left lateral position. A third heart sound is also heard due to the sudden inflow in to the left ventricle as in conditions like mitral regurgitation or ventricular septal defect which complicates STEMI.S3 and S4 from left ventricle are best heard at the apex whereas those arising from the right ventricle are best heard in the left sternal border and increase with inspiration.

Murmurs: Systolic murmurs are commonly audible in patients with STEMI due to mitral regurgitation secondary to the dysfunction of mitral valve apparatus. An apical holosystolic murmur with a prominent thrill may arise due to the rupture of head of papillary muscle. In the case of interventricular septal rupture, the holosystolic murmur is heard along the left sternal border. The systolic murmur of tricuspid regurgitation is also heard along the left sterna border and it increases in intensity with inspiration. Tricuspid regurgitation is due to right ventricular infarction, or by infarction of right ventricular papillary muscle. It is also accompanied by prominent c-v wave in jugular venous pulse and RVS4.

Frictional rubs: They are seen in patients with a large transmural infarcts.[58] They are commonly noted in the second or third day. They

are heard commonly along the left sterna border or just medial to the apex. The patients with frictional rub may have pericardial effusion on echocardiography. Delayed onset frictional rub with signs of pericarditis are seen in post myocardial infarction syndrome or the Dressler's syndrome which is rare nowadays. Sometimes only the systolic portion of the rub is heard mimicking a systolic murmur of ventricular septal rupture or of mitral regurgitation.

LABORATORY INVESTIGATIONS:

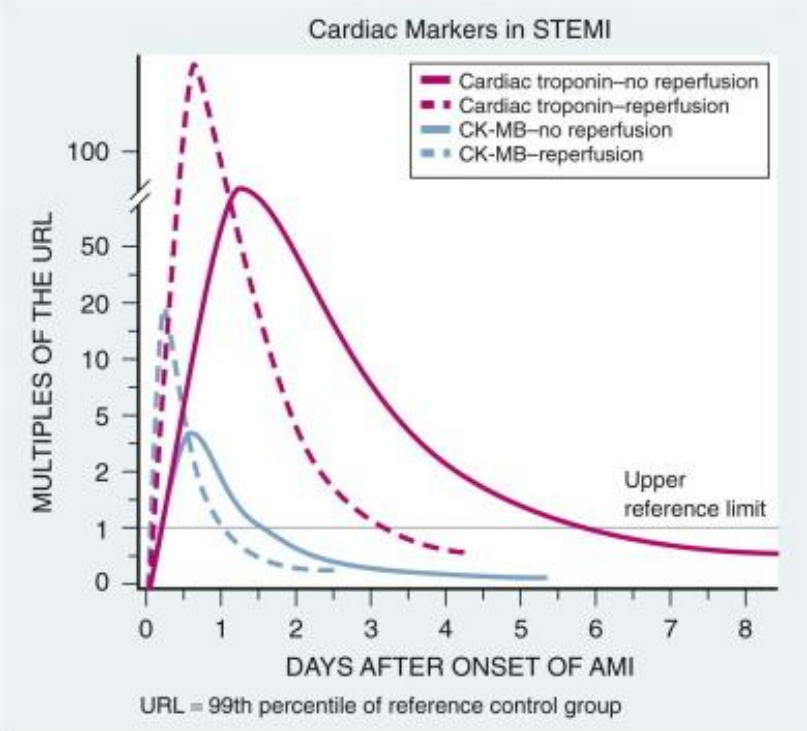
The availability of cardiac biomarkers has helped the clinicians to diagnose MI in one third of the patients who did not fulfil the criteria for MI in the past. [59] it is important for the clinicians not to rely on the biomarker assays to initiate the specific treatment for STEMI patient. A 12 lead ECG should serve to initiate such strategies. Cardiac enzymes are proteins released into the blood stream after the death of cardiac muscles.

Myocardial necrosis compromises the integrity of the sarcolemmal membrane and as a result of which there is leak of intracellular macromolecules (cardiac biomarkers) in to the interstitium and then in to the lymphatics which is around the area of infarct. The rate of appearance of these biomarkers in blood depend on several factors like molecular weight, intracellular location, local blood and lymphatic flow and rate of elimination from the blood[60,61] (see fig below)

BIOMARKER	MOLECULAR WEIGHT (DA)	RANGE OF TIME TO INITIAL ELEVATION (HR)	MEAN TIME TO PEAK ELEVATIONS (NONREPERFUSED)	TIME TO RETURN TO NORMAL RANGE
Frequently Used in Clinical Practice				
MB-CK [*]	86,000	3-12	24 hr	48-72 hr
cTnI [†]	23,500	3-12	24 hr	5-10 days
cTnT	33,000	3-12	12 hr-2 days	5-14 days
Infrequently Used in Clinical Practice				
Myoglobin	17,800	1-4	6-7 hr	24 hr
MB-CK tissue isoform	86,000	2-6	18 hr	Unknown
MM-CK tissue isoform	86,000	1-6	12 hr	38 hr

Modified from Antman EM, Anbe DT, Armstrong PW, et al: ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines fo the Management of Patients with Acute Myocardial Infarction). Circulation 110:e82, 2004.

(Fig6: showing various cardiac biomarkers and their rates of rise and fall)



(Fig7: showing the rate of appearance and disappearance of various cardiac biomarkers)

CREATININE PHOSPHOKINASE:

Three isoenzymes exist (MM, BB, MB). BB subtype is seen in brain and kidneys. The skeletal muscle contains the MM subtype and the cardiac muscles contain both MM and MB subtypes. The MB isoenzyme is also present in small quantities in the intestine, tongue, diaphragm, uterus and prostate. Strenuous exercise is associated with rise in both the than the CK-MB and the total creatinine kinase.[62]. For practical purposes, the elevation of CK-MB may be considered due to myocardial infarction unless proved otherwise. CK-MB is analysed by specific enzyme immunoassays which use monoclonal antibodies against CK-MB. [63] it is important to evaluate the temporal rise and fall of serial values rather than relying on a single value. At present, cardiac specific troponins play an important role in diagnosing myocardial infarction because of its specificity towards the cardiac muscle[64]. In addition to STEMI other forms of injury to cardiac muscle in the form of myocarditis, trauma, cardiac catheterization, shock and cardiac surgery can also cause rise in CK-MB values. Creatine phospho kinase starts rising 6 to 8 hours following injury and attains its peak in 24 hours and then decreases and reaches normal values in 3 to 4 days. CPK levels are also markedly increased in conditions like muscular dystrophy, inflammatory muscle diseases, alcohol intoxication with or without delirium tremens, diabetes mellitus with or without ketoacidosis, convulsions, psychosis. Sensitivity and specificity of CPK is not as high as Troponins.

TROPONINS:

The Troponin consists of three subunits. These consists of troponin C, troponin I, and troponin C. the troponin C binds Ca^{2+}, troponin I which binds actin, and troponin T which binds to topomyosin. Majoriy of cardiac troponin T is in the troponin complex. Minor amount is in the cytosolic pool (6%). 2 to 5% of troponin I is in the cytosolic pool. Cardiac troponin T is a 33,000 dalton protein. When a infarction occurs, initially the troponin is released from the cytosolic pool followed later from the structural pool.[34] Different genes code troponin T and troponin I. Evidence tells that troponin complexes degrade in to various fragments and this may form the basis of getting insight in to the pathophysiologic events involved(ischemia or reperfusion) in the near future. troponin T starts rising 3 to 6 hours after the onset peaks at 24 to 48 hours and then returns to baseline in 7 to 14 days. This persistence helps in late diagnosis of MI. Patients with STEMI who undergo thrombolysis and successful recanalization have rapid release of cardiac Troponins and hence denote reperfusion.[66] At the initial presentation, troponin levels may be normal. So it is necessary to repeat the troponin levels at regular intervals. Studies tell that the risk of death from acute coronary syndromre is directly proportional to the cardiac troponin level. Patients with no detectable troponins have a good short term prognosis.

Elevated levels are also associated with conditions like congestive cardiac failure, sepsis, acute pulmonary embolism, chronic kidney disease, myocarditis and aortic dissection.

SGOT:

In a typical patient with acute myocardial infarction, the SGOT activity goes more than the the normal range within 8 to 12 hours following onset of chest pain. It then reaches a peak within 8 days and then returning to normal levels one month following the initial insult. Other causes of sustained elevated SGOT levels are hepatic congestion, primary liver diseases, skeletal muscle disorders, shock. Myocarditis may also cause elevated levels of SGOT and it parallels the activity of the disease. if elevated in pericarditis, it may be due to subepicardial injury[65]. Around 11 percent of female patients taking oral contraceptives can have elevated SGOT levels. SGOT may also raise following cardiac catheterization.

Activity of many enzymes including aldolase,malic dehydrogenase, isomerase, and ICD (Iso Citrate Dehydrogenase) may increase following myocardial infarction.[67] Serum GGT, a lysosomal enzyme, exhibits increased activity late, reaching a peak within 8 days and returning to normal approximately 1 month following the initial insult.

Recommendations for Cardiac Enzyme Measurement:

Cardiac enzymes are measured in anyone with suspected myocardial injury. From the cost- effective perspective, it is not necessary to measure both the troponins and CPK. Diagnosis of MI is made with elevations of troponin t, troponin I or CPK-MB. Or with serial measurements every 8 to 12 hours if the initial value is within normal limits. Retrospective diagnosis of myocardial infarction in the presence of skeletal muscle injury is more readily made with cardiac troponin measurement. Assays for the cardiac-specific troponins should supersede assays for CK-MB, not only for the diagnosis of MI but also for the assessment of reperfusion, reinfarction, and estimation of infarct size.[67]

Other laboratory investigations:

Serum lipids:

During the first 24 to 48 hours of admission, total cholesterol and serum HDL levels remain near the baseline and and after that there is a precipitous fall of these levels. The fall in HDL cholesterol is more than that of total cholesterol and hence the HDL cholesterol ratio is not useful in the risk assessment. It is mandatory to obtain lipid profile in all patients admitted with STEMI within 24 to 48 hours of symptoms. Studies tell that hypolipidemic therapy improves the endothelial function and inhibits thrombus formation. This forms the basis of instituting early

hypolipidemic therapy in patients who are admitted with STEMI.[68]. For those who are admitted beyond 24 to 48 hours, accurate measurement of lipids is made only after 8 weeks after the infarction

Hematologic findings:

Elevation of white blood count start developing within 2 hours of chest pain and peaks in 2 to 4 days after infarction. The levels can range from 12,000 to 15,000. Sometimes even higher. There is propensity of differential count to shift towards the band forms.

The ESR is normal during the first two days and after that it rises reaching a peak on fourth or fifth day and may be elevated for weeks. There is also elevated hematocrit and CRP levels. Presenting haemoglobin values also predicts major cardiovascular events.[69] Cardiovascular mortality increases at values less than 14 to 15 mg/dl and more than 17 mg/dl. Former is due to anemia resulting in diminished tissue delivery of oxygen and latter is due to the increased blood viscosity.

Electrocardiography :

Electrocardiogram forms one of the corners tone in the diagnosis of STEMI. Many factors limit the ability of the ECG in localisation such as extent of myocardial injury, age of infarct, location, presence of conduction defects, presence of previous infarcts or pericarditis,

electrolyte disturbances. Changes in ST segment and T waves can be present in a number of conditions like pericarditis, stable and unstable angina pectoris, ventricular hypertrophy, early repolarisation, electrolyte imbalance, shock. Serial ECG help in differentiating these conditions. ECG also helps in localizing the site of occlusion. In addition to the diagnostic and prognostic use, ECGs also provide valuable information regarding the success of reperfusion after STEMI.[70] most patients bear the ECG changes for rest of their lives. But in a few, the ECG changes can even return to normal after many years. Many conditions produe ECG changes similar to infarction. Such ‘pseudoinfarction’ patterns are seen in ventricular hypertrophy, conduction disturbances, preexcitation, primary myocardial disease, pneumothorax, pulmonary embolism, amyloidosis, tumors of the heart, traumatic heart disease, intracranial haemorrhage, hyperkalemia, pericarditis, early repolarisation, and cardiac sarcoidosis. The presence or absence of Q waves does not reliably distinguish between transmural and non transmural infarction. Q waves denote abnormal electrical activity. Data tell that MI without ST segment elevations can occur more commonly in older patients and in patients with history of prior myocardial infarction.

Patients with Q waves and ST segment changes diagnostic of STEMI in one territory often have ST segment depression in other

territories. It implies poor prognosis and is caused by ischemia in a territory other than the area of infarction. It is termed as ‘ischemia at a distance’.

ECG changes in right ventricular infarction:

Right ventricular infarction usually presents with ST segment elevation in the right precordial leads (V1, V3R to V6R). It is a relatively sensitive and specific sign. Occasionally, right ventricular infarction presents with ST elevation in leads V2 and lead V3. A concurrent inferior wall injury suppresses this anterior ST segment elevation. Also a right ventricular injury reduces the anterior ST segment depression which is observed in a case of inferior wall myocardial infarction.

Echocardiography:

The portability of echocardiogram makes it an ideal equipment for assessing patients with myocardial infarction. [71] in patients with chest pain but with nondiagnostic ECG, echocardiogram helps in diagnosing by identifying the areas of disordered contraction which is consistent with ischemia. Echocardiogram also helps in evaluating the patients with chestpain and suspected aortic dissection. Presence of intimal flap is consistent with aortic dissection and which is a major contraindication for thrombolysis. The LV function estimated from echocardiogram correlates well with the measurements from angiograms and is helpful in the

prognosis after MI. the early use of echocardiogram can help identify potentially viable but stunned myocardium, residual provocable ischemia, patients at risk for development of congestive cardiac failure and mechanical complications of MI. Although transthoracic echo is sufficient, trans-esophageal ECHO is used in those with poor ECHO window. Doppler technique helps in assessing the blood flow in the cardiac chambers and across the cardiac valves. When used in conjunction with echocardiogram, it can help detect and assess the severity of mitral or tricuspid regurgitation. It can help identifying the site of ventricular septal rupture, quantification of shunt flow across and assessment of cardiac tamponade.

Computed tomography:

It helps in assessing the cavity dimensions and wall thickness, detects left ventricular aneurysm, and in patients with STEMI, identifies intracardiac thrombi. Although a less convenient technique, computed tomography is more sensitive than echocardiogram in the detection of thrombus.

Cardiac Magnetic resonance imaging:

Cardiac Magnetic Resonance (CMR) imaging permits early recognition of MI and gives an assessment of the severity of ischemic insult. It can assess the perfusion of infarcted and non infracted tissue as well as the reperfused myocardium. It identifies myocardial edema, fibrosis, wall thinning, fibrosis, hypertrophy, assess ventricular chamber size and segmental wall motion and identifies the transition between ischemia and infarction, [72]main disadvantage is the need to transport the patient in acute phase which is not feasible.

Contrast enhanced CMR can detect myocardial infarction accurately. The transmural extent of late gadolinium enhancement in regions of dysfunctional myocardium accurately predicts the likelihood of contractile recovery after successful restoration of coronary flow from mechanical revascularization.[90] Apart from detecting infarction, this imaging technique can characterize the presence and size of microvascular obstruction from infarction.

Nuclear imaging:

Radionucleotide angiography, perfusion imaging, infarct- avid scintigraphy, and positron emission tomography are being used to evaluate patients with STEMI. [73] Nuclear imaging techniques are used in detecting MI, assessing infarct size, collateral flow, and jeopardized

myocardium and thus helps in establish prognosis. They are used in situations where the triad of clinical history, electrocardiography and serum markers are unreliable or unavailable.

Estimation of infarct size:

The quantity of the myocardium infracted has important prognostic implications.

The sum of ST segment elevations measured from multiple precordial leads correlates with the extent of myocardial injury in patients with anterior wall myocardial infarction. [74] Studies also show relationship between the number of leads showing ST-segment elevation and mortality rate.

Serial measurement of proteins released by the dead myocardium help in determining the infarct size. Peak CK or CK-MB values can provide an approximate estimate of infarct size. Reperfusion can washout these enzymes resulting in early peaking thus limiting its usefulness in estimating infarct size. Measurement of cardiac specific Troponin levels, even in cases of successful reperfusion may provide a reliable estimate of infarct size, because such late Troponin measurements reflect delayed release from from the myofilament bound pool in injured myocytes.[75]

Newer imaging techniques:

Contrast enhanced CMR can aid in assessment of infarct size. It also demonstrates regional heterogenecity of infarction patterns in patients with persistently occluded arteries, compared with those with successfully reperfused vessels.[76]

MANAGEMENT:

Prehospital care:

The prehospital care is a crucial element in the survival of patients with suspected STEMI. Most of the deaths occur due to ventricular fibrillation and and usually within one hour. Hence transporting the patient to a hospital with facilities is of prime importance. Major cause of delay from the onset of symptoms to reperfusion include

1] Delay of the patient in recognising the seriousness of the problem

2] Prehospital treatment and transport of the patient.

3] The time for diagnostic measures and initiation of treatment in the hospital (door-to-needle time or door-to- balloon time)

4] Time from initiation of treatment and restoration of low.

Proper patient education is necessary in preventing the time delay of the patient in seeking medical attention. Older age, female sex, black race, low socioeconomic status, history of angina, diabetes or both, consulting a spouse or a relative are factors associated with a delay in

seeking medical advice.[77,78] Patients should be advised to seek medical advice if symptoms such as chest discomfort, dyspnea. Patient should be instructed in the proper use of sublingual nitroglycerine and to call emergency services if the cardiac type of pain persists for more than five minutes. [79]

Prehospital fibrinolysis:

Early treatment of STEMI provides greater benefit. A meta analysis of all the available trials showed a 17 percent reduction I mortality. The CAPTIM trial which compared prehospital fibrinolysis with the primary PCI showed a lesser mortality with the former if the patients are being treated within two hours of onset of symptoms. Prehospital fibrinolysis is reasonable bin settings where the physicians are present in the ambulance or there is fully trained paramedics who are fully capable of obtaining and transmitting the 12- lead ECG and initiate prehospital thrombolysis.[80,81]

Because the 12-lead ECG is at the centre of the decision pathway for initiation of reperfusion therapy, it should be obtained promptly (≤10 minutes) in patients presenting with ischemic discomfort. The decision whether to thrombolyse the patient or to do primary intervention depends on the availability of skilled personnel, time taken from onset of pain to intervention, presence or absence of facilities in the treating hospital.

Thrombolysis is preferred if the presentation is less than 3 hours, the catheterization facilities are not available, there is difficulty in vascular access, there is possible delay in transporting the patient to an equipped center.

Contraindications for thrombolysis:

1] Prior intra cranial haemorrhage

2] Known structural cerebral vascular lesions like arteriovenous malformations.

3] Known intracranial neoplasm

4] Ischemic stroke within 3 months except acute ischemic stroke within 3 hour.

5] Suspected aortic dissection

6] Any active bleeding except those during menses.

7] Any closed head or facial trauma within 3 months

Other measures:

Aspirin: Aspirin forms part of the initial management of patients with suspected STEMI. Because low dose may take several days to achieve full antiplatelet effect, at least 162 to 325mg should administered in emergency department. The patient is asked to chew the tablet which promotes faster absorption than through the gastric route.

Control of Cardiac Pain : Control of cardiac pain is very important in treating patients with STEMI. Control of pain uses a combination of nitrates, analgesics (e.g., morphine), oxygen, beta blockers(in selected patients)[82] since the pain in STEMI is due to ongoing ischemia, interventions that improve the oxygen supply- demand relationship can alleviate the cause of pain.

Analgesics: Morphine remains the drug of choice in treatment of pain in patients with myocardial infarction unless there is a well documented history of morphine hypersensitivity. A dose of 4 to 8 mg should be given intravenously and should be repeated at intervals of 5 to 15 minutes until the pain is relieved or there is evidence of toxicity like hypotension, depression of respiration or severe vomiting. Morphine reduces the anxiety and decreases the activity of autonomic nervous system. It causes peripheral arterial and venous dilatation in cases with pulmonary edema. It slows the heart rate secondary to withdrawl of sympathetic tone and augmentation of vagal tone.

Hypotension following the administration of nitroglycerin and morphine can be minimized by maintaining the patient in a supine position and elevating the lower extremities if systolic arterial pressure declines below 100 mm Hg. Use of atropine can counteract the

vagomimetic action of morphine. Respiratory depression is an unusual complication of morphine in the presence of severe pain or pulmonary edema. Respiratory depression can be treated with naloxone 0.1 to 0.2 mg initially and repeated 15 minutes later if necessary.

Nitrates: By acting as coronary vasodilators and by decreasing ventricular preload, sublingual nitrates form one of the important drugs in treating most patients with ACS. Sublingual nitroglycerine is contraindicated in patients with inferior wall myocardial infarction or in those with systolic blood pressure less than 90 mmHg.[83] . The hypotension and bradycardia caused by nitrates can be reversed by intravenous atropine.

Beta blockers: they relieve the ischemic pain, reduce the need for analgesics, and reduce the infarct size and life threatening arrhythmias. It is better to avoid beta blockers in patients with killip class II or higher, in those with bradycardia, those with AV blocks. Metoprolol is given as three 5 mg intravenous doses.

Oxygen: Hypoxemia in patients with STEMI results from ventilation perfusion abnormalities as a result of left ventricular failure. Pneumonia and intrinsic pulmonary diseases are additional causes. It is common practice to use oxygen for 12-48 hours after admission. But

studies say that oxygen is required in those with saturation less than 90%. In others, oxygen therapy is not useful infact it can even lower the cardiac output by increasing the systemic vascular resistance and arterial pressure. Usually, 2 to 4 litres of 100 percent oxygen is necessary for about 6 to 12 hours. If patient not responds to this mode, flow rate has to be increased or in cases of pulmonary edema, endotracheal intubation may be necessary.

Reduction of infarct size: Bed rest both physical and emotional is needed and this is achieved by using mild sedation and treating in a quiet atmosphere. Betablockers reduce the infarct size and they should be used unless otherwise contraindicated. Marked sinus bradycardia and hypotension should be adequately treated. All forms of tachyarrhythmia should be treated as they increase myocardial oxygen demands.[84] Congestive cardiac failure should be treated promptly with inhibitors of RAAS unless contraindications are present. Oxygen enriched air should be used. Blood pressure should be maintained within a optimal range. Severe anemia if present should be treated with packed cell transfusions.

REPERFUSION THERAPY:

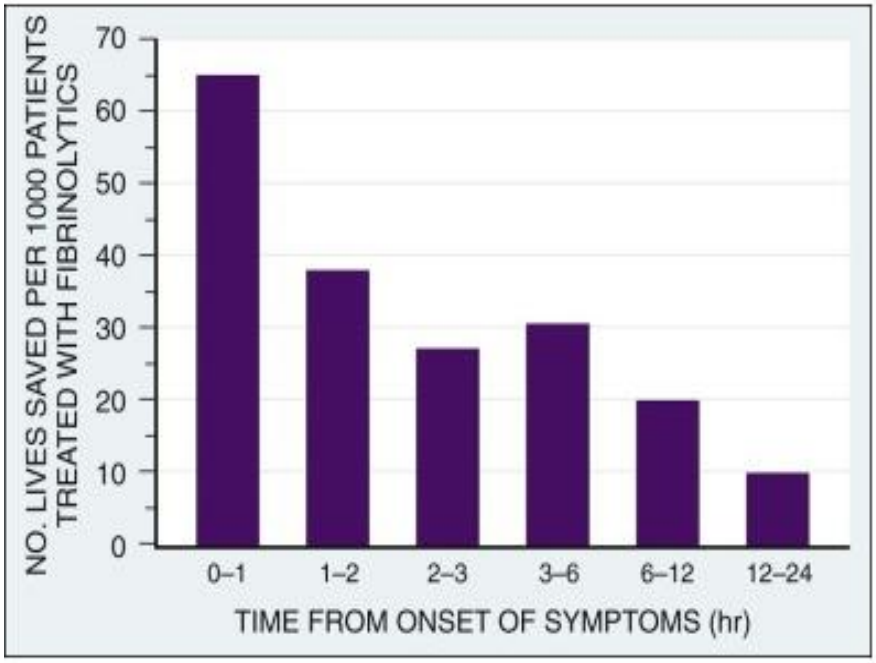
Fibrinolysis recanalizes the occluded artery in a case of STEMI thereby causing restoration of blood flow resulting in decrease in infarct

size and improvement of myocardial function.[85,86]. Nowadays PCI are done in large numbers to treat such patients

Several methods are used in evaluating the adequacy of myocardial perfusion. Electrocardiographic changes in the form of ST segment resolution can help in predicting the outcomes in a case of STEMI.[87,88] persistence of ST segment changes in a patient after successful PCI denotes worse prognosis in the form of increased left ventricular dysfunction and mortality. This can be due to microvascular damage in the infarct zone. Thus the 12- lead ECG is a marker which reflects the myocyte integrity and reflects the inadequacy of myocardial perfusion[89]. Also the cardiac biomarkers provide important information regarding the prognosis in STEMI patients[90].

Fibrinolysis:

Early fibrinolysis improves the survival in patients with STEMI.[84] It is beneficial if it is administered as early as possible. Best results are obtained if it is given within 2 hours of the onset of symptoms.[91]



(Fig8: showing effect of early thrombolysis on the patient's lives[)]

A number of agents are used in fibrinolysis like streptokinase, and tissue plasminogen activators. The choice of the drug to be used depends on the duration of onset, age, comorbidities. In patients presenting within 4 hours of symptoms, the important factor is the speed with which the occluded vessel is reperfused. This can be achieved by high intensity fibrinolytic such as t-PA. But in those whose risk of death is low, and in those where the risk of intracranial bleed is high, streptokinase and t-PA are equivalent choices. For those who present between 4 and 12 hours after the onset of chest pain, the speed of reperfusion is of lesser importance and thus streptokinase and t-PA are of equal options.

PCI:

When performed rapidly and in a experienced center, primary PCI is superior to reperfusion therapy.[92] Controversy arises regarding the best approach when immediate PCI can't be done and delay occurs. The outcome of the PCI varies with the experience of the operator and the center. Therefore, the optimal therapy in treating the patient depends on the available resources and the type of patients. When a experienced team is available and door to balloon time can be achieved <90 minutes, PCI is the ideal method of reperfusion. Also in old patients, who have increased risk of haemorrhage from fibrinolysis, PCI is the better option. The thrombi mature over time and become resistant to thrombolysis. In such conditions (ie> 3 hrs), PCI is the best option which can open up the occluded vessel. When the diagnosis is in doubt, PCI is the best procedure.

Surgery:

Surgery in acute MI performed if the chest pain persist inspite of thrombolysis or primary PCI; presence of high risk lesions like left main stenosis; ventricular septal rupture or severe mitral regurgitation complicating MI.

Anticoagulant and antiplatelet therapy:

The aim of administering anticoagulants in STEMI patients are as follows

1. Prevention of deep venous thrombosis.
2. Prevention of pulmonary embolism
3. Preventing thrombus formation in the ventricle.
4. Preventing emboli to brain.
5. Establishment and maintenance of infarct related artery patency

Anticoagulants should be continued for at least 48 hours after thrombolysis and maintained to an aPTT of 1.5 to 3 times the normal.

Unfractioned Heparin(UFH) was used initially. Disadvantages in using UFH are that it depends on anti thrombin III for inhibiting thrombin activity, its sensitivity to platelet factor 4, inability to inhibit clot bound thrombin and interpatient variability. In contrast, the Low Molecular Weight Heparins(LMWH) are stable, have reliable anticoagulant effect and have high bioavailability.

Antiplatelet therapy:

The common antiplatelets used are aspirin, clopidogrel, ticlopidine, prasugrel , ticagrelor. Disruption of coronary artery plaque is major event in the evolution of myocardial infarction. [93] Platelets are released in response to fibrinolysis and platelet rich thrombi are more resistant to fibrinolysis than fibrin and erythrocyte rich thrombi. Thus the use of antiplatelet drug is very important in a case of STEMI. The most extensively used drug is aspirin. It is used in a loading dose of 162 to 325 mg followed by a continuation dose of 75 to 162 mg. Clopidogrel or ticlopidine are used if patient does not tolerate aspirin. Antilipidemics, adequate bed rest, stool softeners, appropriate management of arrhythmias and other complications, use of RAAS blockers and aldosterone blockers are important in managing patients with STEMI.

Emerging therapy:

Studies are going on for a better improvement of the health of STEMI patients. Anti Neutrophilic drugs, ET-1r antagonists, TXA2r antagonists, antiplatelets are being studied for preventing reperfusion related injury, thrombus aspiration techniques help in removing the occluded thrombus, and methods to reduce the oxygen consumption are being studied. The burgeoning field of cardiac regenerative medicine is now focusing on several approaches using endogenous and exogenous sources of cells that may give rise to myocytes.

AIM OF THE STUDY

To identify left ventricular ejection fraction of less than or equal to 40 percent by quantitatie Troponin T measurement after first episode of ST elevation Myocardial Infarction.

MATERIALS AND METHODS

This study was conducted in Government Royapettah hospital in the Department of Medicine between July and December 2012. Fifty consecutive patients with first attack of ST elevation of myocardial infarction were selected and observed. Myocardial infarction was diagnosed by the following criteria

1. Typical cardiac chest pain
2. Presence of ST segment elevation of more than 2mm in chest leads or more than 1mm in 2 contiguous limb leads or presence of Q waves in two consecutive leads.
3. Elevated Creatinine Kinase levels more than twice from the baseline.

Exclusion criteria:

1. Patients with previous history of myocardial infarction
2. Severe renal impairment
3. History of cardiac failure

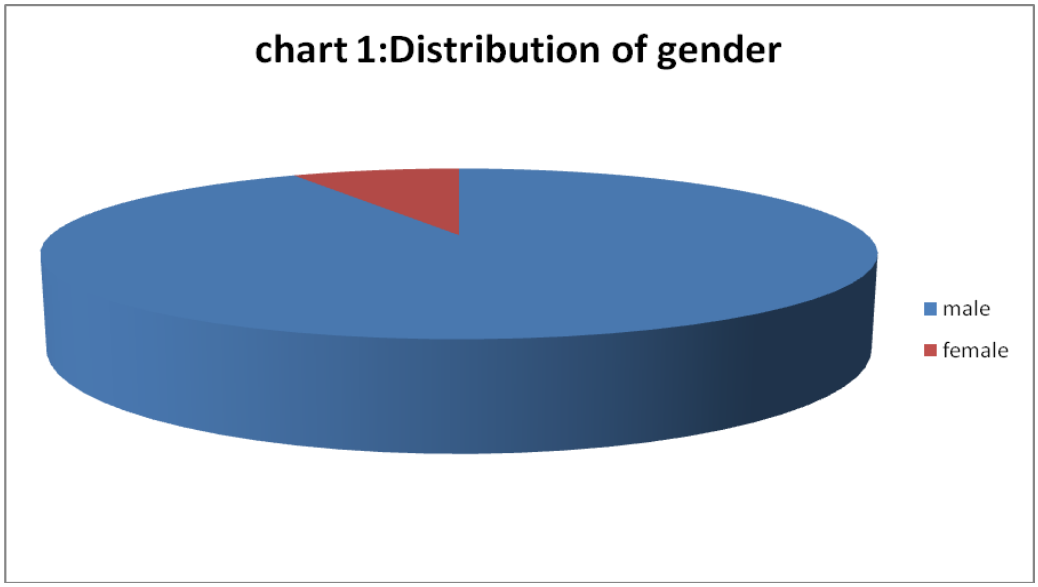
Troponin T levels are measured 12 to 48 hours after admission so as to obtain its peak value. All patients received standard therapy like anti platelets, anti lipidemics, anti coagulation with heparin, fibrinolytics (if

the criteria for administering these drugs are met) and supportive care. Two dimensional Echocardiography was done 3 to 4 weeks later and ejection fraction was measured.

The relationship between left ventricular ejection fraction and troponinT concentration was studied using spearman's correlation coefficient. The relation between Troponin T concentration and ejection fraction was examined by constructing a receiver operator characteristic (ROC) curve. Patients were initially categorised in to two groups; those with ejection fraction of less than 40 percent and those with ejection fraction more than 40 percent. Then sensitivity and specificity of Troponin was determined. Sensitivity was plotted against 1- specificity and ROC curve was produced. The test is better if the curve is near the top left corner. The point of inflection of the ROC curve allows selection of the best trade off between sensitivity and specificity.

RESULTS

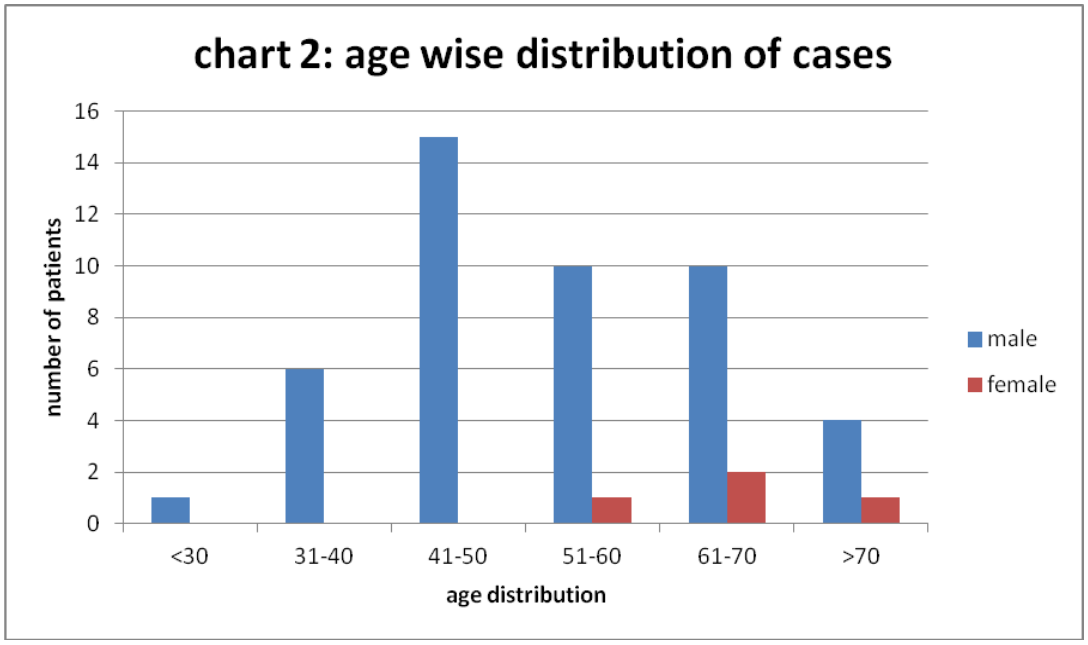
Total people under the study were 50. Of the total 50 people who were involved in the study, 46 were male (90%) and 4 were females (10%).



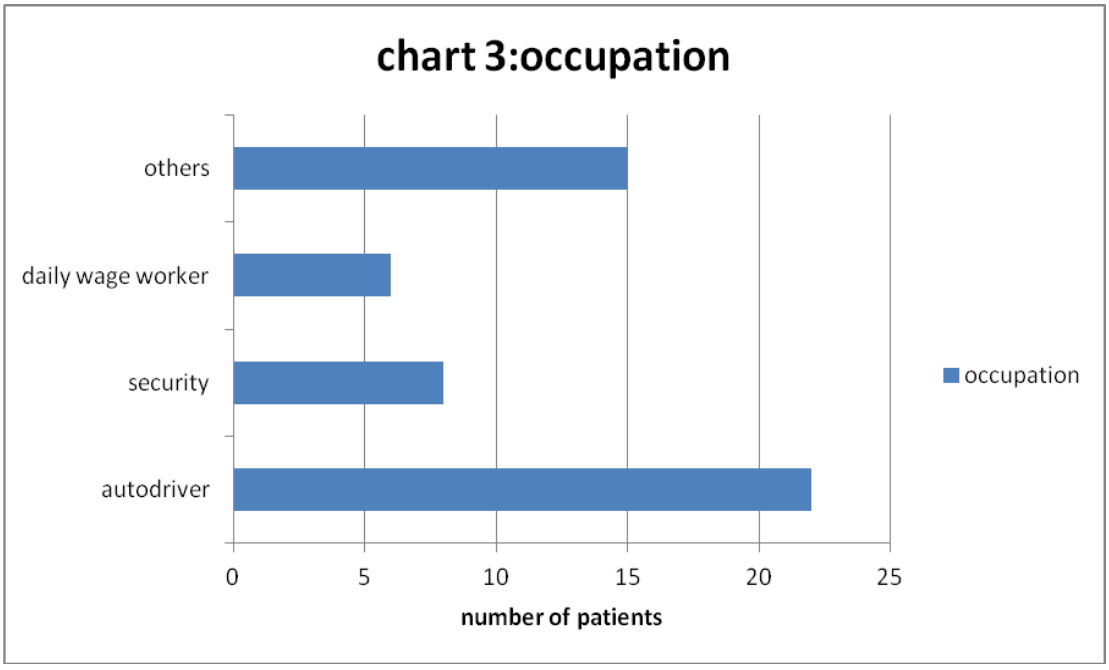
Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
age	50	28	80	54.34	12.356
Valid N (listwise)	50				

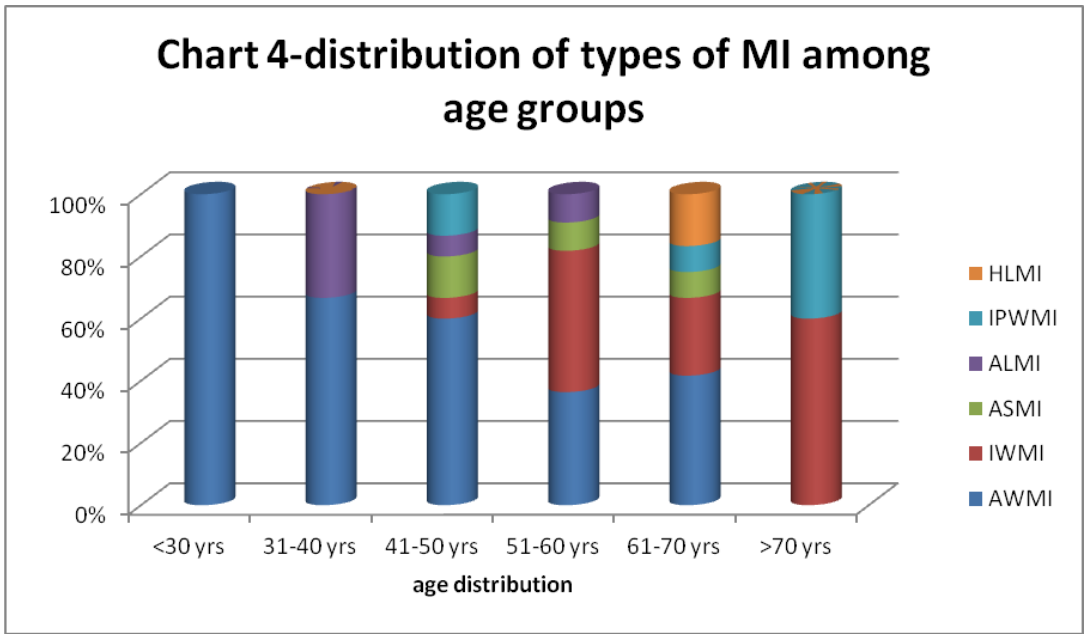
The mean age of the study group is 54.34 years (max 28 yrs and min 80 yrs) with a standard deviation of 12.356



Most of the patients were in the age group of 41 to 50 yrs(30 percent) followed by age group between 61 to 70 yrs(24%). Incidence of myocardial infarction in females rises after 50 yrs whereas in males it peaks in the age group of 40 to 50 yrs.



Considering the occupation, the incidence is more common among the autodrivers (44 percent) followed by others

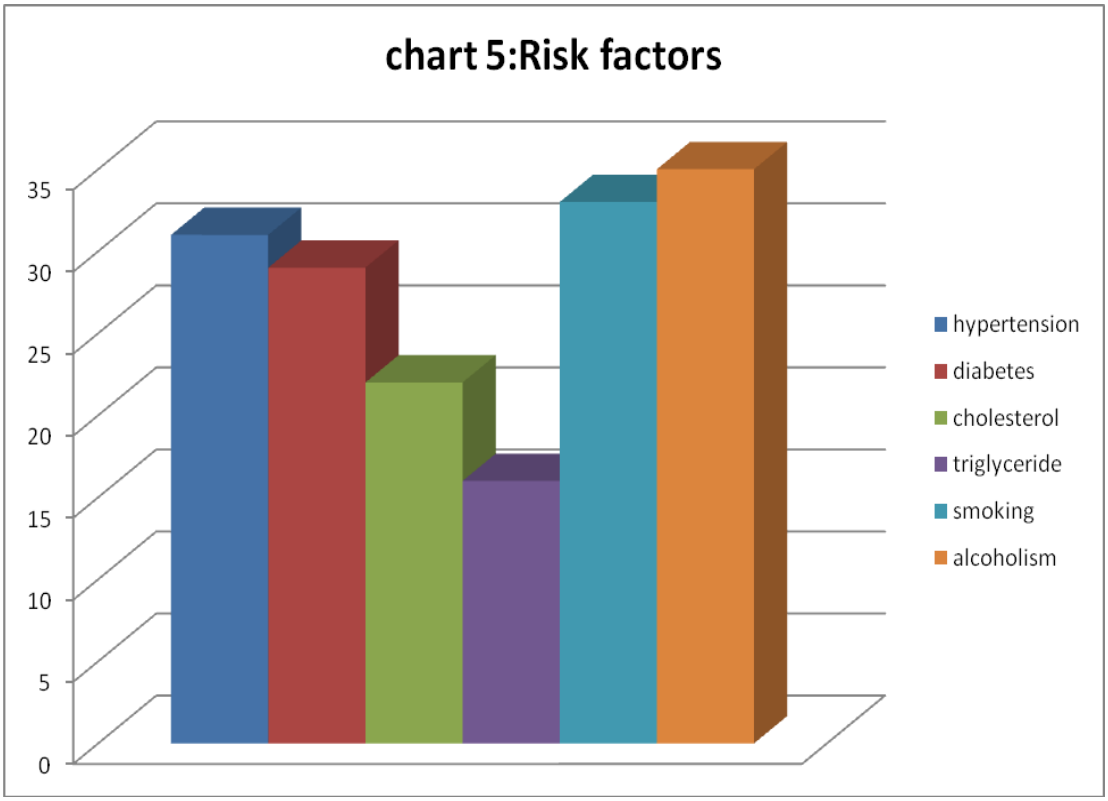


Type of myocardial infarction also varies with ages. The most common type of myocardial infarction was acute anterior wall infarction which is present in 22 patients (44%). Anterior wall MI was common among younger age groups whereas in the older age group, inferior wall MI predominated. Of the 50 patients, 31 were hypertensive (62%), 29 of them (58%) were diabetic. Hypercholesterolemia was present in 22 patients (44%), hypertriglyceridemia in 16 (32%). There were 33 smokers (66%) and 35 alcoholics (70%).

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
age	50	28	80	54.34	12.356
sugar	50	73	347	145.90	45.903
urea	50	22	84	42.16	17.171
creatinine	50	.3000	2.2000	1.144000	.3855343
cholesterol	50	127	378	207.90	50.477
TGL	50	73	329	182.66	66.199
ejn frction	50	30	65	43.28	8.636
SHT(yrs)	50	0	20	4.66	4.830
SBP	50	100	176	144.20	19.518
DBP	50	30	110	88.04	15.761
diabetes(yrs)	50	0	15	4.18	4.543
trop T levels	50	.2340	10.0000	5.644920	3.3080123
Valid N (listwise)	50				

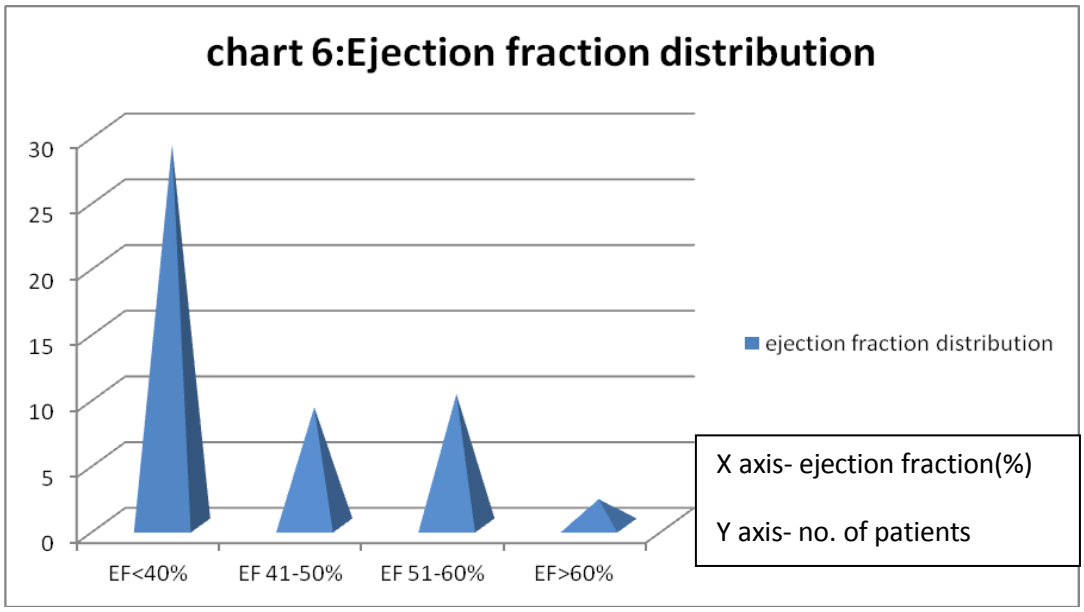
The mean cholesterol value is 207.90mg/dl, blood sugar level 145.90 mg/dl, Triglyceride- 182.66mg/dl, ejection fraction- 43.28, mean systolic blood pressure is 144.20mm Hg(minimum 100 mmHg; maximum 176 mm Hg), mean diastolic blood pressure is 88.04mmHg(min-30 mm Hg and max-110 mm Hg). The mean Troponin level was 5.644 with the lowest value being 0.234 and the greatest value being10.



Ejection fraction interval

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	29	58.0	58.0	58.0
	2.00	21	42.0	42.0	100.0
	Total	50	100.0	100.0	

Of the patients admitted, 29 of them had ejection fraction less than 40 percent(58%) and 21 of them had ejection fraction more than 40 percent.(42%)



qSymmetric Measures

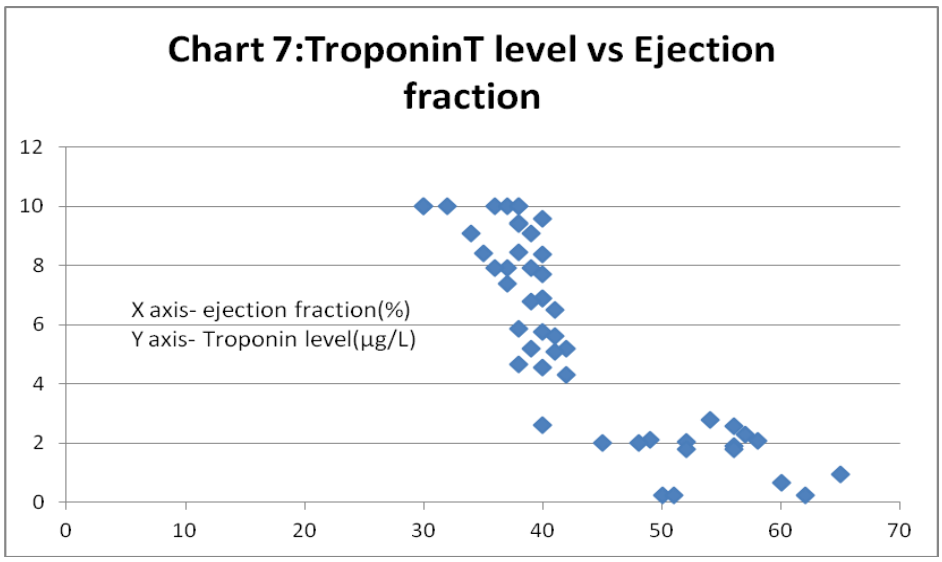
		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	-.860	.027	-11.656	.000[c]
Ordinal by Ordinal	Spearman Correlation	-.874	.029	-12.473	.000[c]
N of Valid Cases		50			

a. Not assuming the null hypothesis.

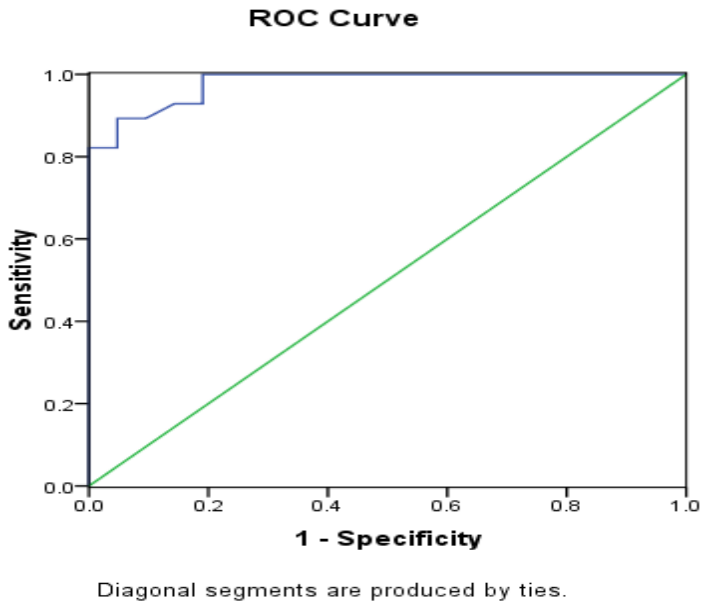
b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

There was a strong negative correlation between the left ventricular ejection fraction and Troponin T levels. Spearman's rank correlation coefficient was -0.874 with p values <0.0001



Analysis of ROC curve produced an area under the curve of 0.970 (95% of confidence interval 0.000 to 1.000. Troponin T value more than 2.9 predicted a LV ejection fraction of <40 % with a high sensitivity and specificity.



Area Under the Curve

Test Result Variable(s):trop T levels

Area	Std. Error[a]	Asymptotic Sig.[b]	Asymptotic 95% Confidence Interval	
			Lower Bound	Upper Bound
.970	.019	.000	.000	1.000

The test result variable(s): trop T levels has at least one tie between the positive actual state group and the negative actual state group. Statistics may be biased.

a. Under the nonparametric assumption

b. Null hypothesis: true area = 0.5

DISCUSSION

Troponin is a highly reliable marker in the detection of cardiac injury. Its use is increasing in modern era in the diagnosis of acute myocardial infarction. Studies tell that the cardiac troponin T measured correlates well with the infarct size and thus indirectly denote left ventricular ejection fraction.

This study shows a strong negative correlation between troponin T measured 12 to 48 hours post MI and the ejection fraction measured by 2D echocardiography. Relation between cTroponin T and ejection fraction by ROC curve show that troponin T concentration of >2.9 is highly sensitive and specific indicator of depressed LV function (LVEF<40 percent) after a first attack of STEMI.

Troponin T forms one of the important markers in the diagnosis of myocardial infarction. It has many advantages in assessing the LV ejection fraction compared to other markers. After an episode of myocardial infarction, Trop T level raises above the baseline and peaks at about 12 hours. However, the plateau phase lasts for about 48 hours. This peak value represents the total amount of myocytes injured. After 12 to 48 hours, the peak value will be missed. Since there is a large time window, repeated sampling is not needed for quantifying the peak value.

Other cardiac injury markers like creatinine kinase and myoglobin are not preferred as they need multiple sampling to determine their peak levels.

A study done by ACR Rao et al showed similar results. They selected 50 consecutive STEMI patients with a first episode of myocardial infarction and did Troponin level and ejection fraction by angiography. Patients with prior history of myocardial infarction were excluded as they may show falsely low ejection fraction. This study showed a strong negative correlation between and LV ejection fraction. Spearman's corellation coefficient was -0.72(95 percent confidence interval) with p<0,0001. Analysis by ROC produced an area under the curve of 0.9773 (95 percent confidence interval 0.9409 1.0131) which was similar to our study. In their study, Trop T more than 2.8μg/L predicted an LVEF of less than 40 percent which was slightly higher in our study.

Another study done by Deepak Somani et al in northern India found a strong negative correlation between Troponin I concentration and left ventricular ejection fraction. The pearson's correlation coefficient was 0.69, which was statistically significant (<0.0001)

Regarding the risk factors, studies tell that the incidence of myocardial infarction increases with age. The incidence of myocardial

infarction rises after the age of 45 in males and more than 55 years in females. Our study too showed similar results with more number of cases in the age group of > 45 years in males and in females it was more prevalent in the post menopausal age group.

Of the 50 people, 66 percent were smokers. Smoking has got influence on blood pressure and sympathetic tone. It also causes reduced myocardial oxygen supply. Long duration of smoking increases the oxidation of Low density lipoprotein cholesterol and impairs endothelium dependent coronary artery vasodilation. It also promotes spontaneous platelet aggregation. This is responsible for the increased incidence of MI among smokers. Critchley JA et al in an article published in JAMA 2003, concluded that smoking cessation as an effective way to reduce CAD mortality by 36 percent as compared to those who continue to smoke.

In a study done by Booth GK et al (lancet 2006;368:29), insulin resistance and diabetes are one of the leading risk factors for Coronary Artery Disease. The presence of diabetes conferred an equivalent risk to aging 15 years, an impact higher than that of smoking. In our study 58 percent of the people were diabetics and smokers outnumbered diabetics. This is high time for emergency steps to be taken to stop smoking in our community as the smokers are on the steep rise.

Although it has been told that mild alcohol consumption has been cardio protective, heavy drinking has got adverse effects on the heart. Although most of the people in our study had multiple risk factors, almost 70 percent of the people were alcoholics who consume in large amounts and for long duration. In a study published by I Byik et al in journal of international medical research in 2007, they found increased coronary disease incidence in those who consumed alcohol in large quantities. This is probably due to reduction in prostaglandin F 1α and cyclic GMP leading on to coronary vasospasm.

LIMITATION OF THE STUDY

1] This study is done in small number of patients. Study in a large group of people is further needed.

2] The left ventricular ejection fraction is measured by 2D echocardiography and not by angiographic methods which is a gold standard. LVEF measured by 2D echo shows lower value than that measured angiographically.

3] The ejection fraction measured by 2D echocardiography is prone for inter observer variations and thus the ejection fraction measured may not reflect the true values.

CONCLUSION

Troponin T show a strong negative correlation with left ventricular ejection after a first episode of myocardial infarction. Its measurement is a quick, cheap, sensitive and highly specific method in identifying cardiac injury and to determine low ejection fraction <40 percent which is associated with complications. Thus its measurement helps in identifying patients who are at higher risk from MI and guide in starting the drugs like ACE inhibitors earlier which provide survival benefit. Multiple measurements are not necessary in determining its peak value as it has got a large time window unlike the other cardiac biomarkers which necessitate multiple measurements to determine their peak level.

DISCLOSURE:

The investigator has not received any form of grants or support from any institution or pharmaceutical company

BIBLIOGRAPHY

1. Antman EM, Tanasijevic MJ, Thompson B, et al. Cardiac specific troponin T levels to predict the risk of mortality in patients with acute coronary syndromes. N Engl J Med 1996;335;1342.

2. Polanczyk CA, Johnson PA, Cook EF, et al. A proposed strategy for utilization of creatine kinase-MB and troponin I in the evaluation of acute chest pain. Am J Cardiol 1999;83:1175.

3. Zimmerman J, Fromm R, Meyer D, et al. Diagnostic marker cooperative study for the diagnosis of myocardial infarction. Circulation 1999; 99:1671â€“1677.

4. Rae-Ellen W. Kavey, MD; Stephen R. Daniels, MD, PhD; Ronald M. Lauer, MD; Dianne L. Atkins, MD; Laura L. Hayman, PhD, RN; Kathryn Taubert, PhD **;**American Heart Association Guidelines for Primary Prevention of Atherosclerotic Cardiovascular Disease Beginning in Childhood

5. Klocke FJ: Coronary blood flow in man. *Prog Cardiovasc Dis* 1976; 19:117.

6. Canty Jr JM: Coronary pressure-function and steady-state pressure-flow relations during autoregulation in the unanesthetized dog. *Circ Res* 1988; 63:821

7. Hoffman JIE: Transmural myocardial perfusion. *Prog Cardiovasc Dis* 1987; 29:429.

8. Feigl EO: Coronary physiology. *Physiol Rev* 1983; 63:1.

9. Kuo L, Davis MJ, Chilian WM: Myogenic activity in isolated subepicardial and subendocardial coronary arterioles. *Am J Physiol* 1988; 255:H1558.

10. Miller FJ, Dellsperger KC, Gutterman DD: Myogenic constriction of human coronary arterioles. *Am J Physiol* 1997; 273:H257.

11. Kloner RA, Jennings RB: Consequences of brief ischemia: Stunning, preconditioning, and their clinical implications: Part 1. *Circulation* 2001; 104:2981.

12. Downey JM, Cohen MV: Reducing infarct size in the setting of acute myocardial infarction. *Prog Cardiovasc Dis* 2006; 48:363.

13. Heusch G: Hibernating myocardium. *Physiol Rev* 1998; 78:1055

14. Kloner RA, Jennings RB: Consequences of brief ischemia: Stunning, preconditioning, and their clinical implications: Part 2. *Circulation* 2001; 104:3158.

15. Bolli R: The late phase of preconditioning. *Circ Res* 2000; 87:972.

16. Lee TH, Goldman L: Evaluation of the patient with acute chest pain. *N Engl J Med* 2000; 342:1187-1195.

17. Pope JH, Ruthazer R, Beshansky JR, et al: Clinical features of emergency department patients presenting with symptoms suggestive of acute cardia ischemia: A multicenter study. *J Thromb Thrombolysis* 1998; 6:63-74.

18. Mueller C, Neumann FJ, Roskamm H, et al: Women do have an improved long-term outcome after non-ST-elevation acute coronary syndromes treated very early and predominantly with percutaneous coronary intervention: A prospective study in 1,450 consecutive patients. *J Am Coll Cardiol* 2002; 40:245-250.

19. Glaser R, Herrmann HC, Murphy S, et al: Benefit of invasive strategy for women with acute coronary syndromes: Observations form the TACTICS-TIMI 18 Trial. *J Am Coll Cardiol* 2002; 39:313A.

20. Bach RG, Cannon CP, Weintraub WS, et al: The effect of routine, early invasive management on outcome for elderly patients with non-ST-segment elevation acute coronary syndromes. *Ann Intern Med* 2004; 141:186-195.

21. Roffi M, Chew DP, Mukherjee D, et al: Platelet glycoprotein IIb/IIIa inhibitors reduce mortality in diabetic patients with non-ST-segment-elevation acute coronary syndromes. *Circulation* 2001; 104:2767-2771.

22. Brosnan R, Newby LK: Acute coronary syndromes in patients with diabetes mellitus: Diagnosis, prognosis, and current management strategies. *Curr Cardiol Rep* 2003; 5:296-302

23. Braunwald E, Antman EM, Beasley JW, et al: ACC/AHA guideline update for the management of patients with unstable angina and non-ST-segment elevation myocardial infarction-2002: Summary Article: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on the Management of Patients With Unstable Angina). *Circulation* 2002; 106:1893-1900

24. Pope JH, Aufderheide TP, Ruthazer R, et al: Missed diagnoses of acute cardiac ischemia in the emergency department. *N Engl J Med* 2000; 342:1163-1170

25. Stein RA, Chaitman BR, Balady GJ, et al: Safety and utility of exercise testing in emergency room chest pain centers: An advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology, American Heart Association. *Circulation* 2000; 102:1463-1467

26. Polanczyk CA, Johnson PA, Hartley LH, et al: Clinical correlates and prognostic significance of early negative exercise tolerance test in patients with

acute chest pain seen in the hospital emergency department. *Am J Cardiol* 1998; 81:288-292.

27. Amsterdam EA, Kirk JD, Diercks DB, et al: Exercise testing in chest pain units: Rationale, implementation, and results. *Cardiol Clin* 2005; 23:503-516.

28. From Goldman L, Cook EF, Johnson PA, et al: Prediction of the need for intensive care in patients who come to emergency departments with acute chest pain. N Engl J Med 334:1498, 1996

29. Kontos MC, Schmidt KL, McCue M, et al: A comprehensive strategy for the evaluation and triage of the chest pain patient: A cost comparison study. *J Nucl Cardiol* 2003; 10:284-290.

30. Kontos MC, Tatum JL: Imaging in the evaluation of the patient with suspected acute coronary syndrome. *Cardiol Clin* 2005; 23:517-530.

31. Udelson JE, Beshansky JR, Ballin DS, et al: Myocardial perfusion imaging for evaluation and triage of patients with suspected acute cardiac ischemia: A randomized controlled trial. *JAMA* 2002; 288:2693-2700.

32. Fleischmann KE, Goldman L, Robiolio PA, et al: Echocardiographic correlates of survival in patients with chest pain. *J Am Coll Cardiol* 1994; 23:1390-1396.

33. Colon 3rd PJ, Mobarek SK, Milani RV, et al: Prognostic value of stress echocardiography in the evaluation of atypical chest pain patients without known coronary artery disease. *Am J Cardiol* 1998; 81:545-551.

34. Thygesen K, Alpert JS, White HD, et al: Universal definition of myocardial infarction. Circulation 2007;116(22):2634-2653

35. Thygesen K, Alpert JS, White HD, et al: Universal definition of myocardial infarction. Circulation 116:2634, 2007.

36. Gaziano TA: Reducing the growing burden of cardiovascular disease in the developing world. *Health Aff (Millwood)* 2007; 26:13.

37. Napoli C, Cacciatore F: Novel pathogenic insights in the primary prevention of cardiovascular disease. *Prog Cardiovasc Dis* 2009; 51:503.

38. Lloyd-Jones D, Adams R, Carnethon M, et al: Heart disease and stroke statistics—2009 update: A report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Circulation 119:e21, 2009.

39. Lloyd-Jones D, Adams R, Carnethon M, et al: Heart disease and stroke statistics—2009 update: A report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. *Circulation* 2009; 119:e21.

40. Antman EM, Peterson ED: Tools for guiding clinical practice from the American Heart Association and the American College of Cardiology: What are they and how should clinicians use them?. *Circulation* 2009; 119:1180.

41. Krumholz HM, Anderson JL, Bachelder BL, et al: ACC/AHA 2008 performance measures for adults with ST-elevation and non-ST-elevation myocardial infarction: A report of the American College of Cardiology/American Heart Association Task Force on Performance Measures (Writing Committee to develop performance measures for ST-elevation and non-ST-elevation myocardial infarction): Developed in collaboration with the American Academy of Family Physicians and the American College of Emergency Physicians: Endorsed by the American Association of Cardiovascular and Pulmonary Rehabilitation, Society for Cardiovascular Angiography and Interventions, and Society of Hospital Medicine. *Circulation* 2008; 118:2596.

42. Kushner FG, Hand M, Smith Jr SC, et al: 2009 focused updates of the ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction (updating the 2004 guideline and 2007 focused update) and the ACC/AHA/SCAI guidelines on percutaneous coronary intervention (updating the 2005 guideline and 2007 focused update): A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation* 2009; 120:2271.

43. Antman EM, Morrow DA, McCabe CH, et al: Enoxaparin versus unfractionated heparin with fibrinolysis for ST-elevation myocardial infarction. *N Engl J Med* 2006; 354:1477.

44. Fox KA, Steg PG, Eagle KA, et al: Decline in rates of death and heart failure in acute coronary syndromes, 1999-2006. *JAMA* 2007; 297:1892

45. Birkhead JS, Weston C, Lowe D: Impact of specialty of admitting physician and type of hospital on care and outcome for myocardial infarction in England and Wales during 2004-5: Observational study. *BMJ* 2006; 332:1306.

46. Modified from Cheitlin MD, McAllister HA, de Castro CM: Myocardial infarction without atherosclerosis. JAMA 231:951, 1975

47. Bayes de Luna A: Location of Q-wave myocardial infarction in the era of cardiac magnetic resonance imaging techniques: An update. *J Electrocardiol* 2007; 40:69.

48. Engblom H, Carlsson MB, Hedstrom E, et al: The endocardial extent of reperfused first-time myocardial infarction is more predictive of pathologic Q waves than is infarct transmurality: A magnetic resonance imaging study. *Clin Physiol Funct Imaging* 2007; 27:101.

49. Achenbach S: Can CT detect the vulnerable coronary plaque?. *Int J Cardiovasc Imaging* 2008; 24:311.

50. Fox JJ, Strauss HW: One step closer to imaging vulnerable plaque in the coronary arteries. *J Nucl Med* 2009; 50:497.

51. Katritsis DG, Pantos J, Efstathopoulos E: Hemodynamic factors and atheromatic plaque rupture in the coronary arteries: From vulnerable plaque to vulnerable coronary segment. *Coron Artery Dis* 2007; 18:229.

52. Wu AHB: Early detection of acute coronary syndromes and risk stratification by multimarker analysis. *Biomarkers Med* 2007; 1:45.

53. Manfredini R, Boari B, Salmi R, et al: Circadian rhythms and reperfusion in patients with acute ST-segment elevation myocardial infarction. *JAMA* 2005; 294:2846.

54. Wagner GS, Macfarlane P, Wellens H, et al: AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: Part VI: Acute ischemia/infarction: A scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society: Endorsed by the International Society for Computerized Electrocardiology. *Circulation* 2009; 119:e262

55. Hamon M, Agostini D, Le Page O, Riddell JW: Prognostic impact of right ventricular involvement in patients with acute myocardial infarction: Meta-analysis. *Crit Care Med* 2008; 36:2023.

56. Popescu BA, Antonini-Canterin F, Temporelli PL, et al: Right ventricular functional recovery after acute myocardial infarction: Relation with left ventricular function and interventricular septum motion. GISSI-3 echo substudy. *Heart* 2005; 91:484

57. Konstam MA: Patterns of ventricular remodeling after myocardial infarction: Clues toward linkage between mechanism and morbidity. *JACC Cardiovasc Imaging* 2008; 1:592.

58. Dorfman TA, Aqel R: Regional pericarditis: A review of the pericardial manifestations of acute myocardial infarction. *Clin Cardiol* 2009; 32:115.

59. Ravkilde J, Horder M, Gerhardt W, et al: Diagnostic performance and prognostic value of serum troponin T in suspected acute myocardial infarction. *Scand J Clin Lab Invest* 1993; 53:677.

60. Jaffe AS, Babuin L, Apple FS: Biomarkers in acute cardiac disease: The present and the future. *J Am Coll Cardiol* 2006; 48:1.

61. Penttila K, Koukkunen H, Halinen M, et al: Myoglobin, creatine kinase MB isoforms and creatine kinase MB mass in early diagnosis of myocardial infarction in patients with acute chest pain. *Clin Biochem* 2002; 35:647.

62. Apple FS: Tissue specificity of cardiac troponin I, cardiac troponin T and creatine kinase-MB. *Clin Chim Acta* 1999; 284:151.

63. Apple FS, Quist HE, Doyle PJ, et al: Plasma 99th percentile reference limits for cardiac troponin and creatine kinase MB mass for use with European Society of Cardiology/American College of Cardiology consensus recommendations. *Clin Chem* 2003; 49:1331.

64. Jaffe AS, Babuin L, Apple FS: Biomarkers in acute cardiac disease: The present and the future. *J Am Coll Cardiol* 2006; 48:1.

65. WEST M, ESHCHAR J, ZIMMERMAN HJ: Sertumenzymology in the diagnosis of myocardial infarction and related cardiovascular conditions.Med Clin N Amer 50: 171, 1966

66. Antman EM, Anbe DT, Armstrong PW, et al: ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of Patients with Acute Myocardial Infarction). *Circulation* 2004; 110:e82.

67. Thygesen K, Alpert JS, White HD, et al: Universal definition of myocardial infarction. *Circulation* 2007; 116:2634.

68. Smith Jr SC, Allen J, Blair SN, et al: AHA/ACC guidelines for secondary prevention for patients with coronary and other atherosclerotic vascular disease: 2006 update: Endorsed by the National Heart, Lung and Blood Institute. *Circulation* 2006; 113:2363.

69. Sabatine MS, Morrow DA, Giugliano RP, et al: Association of hemoglobin levels with clinical outcomes in acute coronary syndromes. *Circulation* 2005; 111:2042.

70. Scirica BM, Morrow DA, Sadowski Z, et al: A strategy of using enoxaparin as adjunctive antithrombin therapy reduces death and recurrent myocardial infarction in patients who achieve early ST-segment resolution after fibrinolytic therapy: The ExTRACT-TIMI 25 ECG study. *Eur Heart J* 2007; 28:2070.

71. Cheitlin MD, Armstrong WF, Aurigemma GP, et al: ACC/AHA/ASE 2003 Guideline Update for the Clinical Application of Echocardiography: Summary article. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASE Committee to Update the 1997 Guidelines for the Clinical Application of Echocardiography). *J Am Soc Echocardiogr* 2003; 16:1091.

72. Ibrahim T, Makowski MR, Jankauskas A, et al: Serial contrast-enhanced cardiac magnetic resonance imaging demonstrates regression of hyperenhancement within the coronary artery wall in patients after acute myocardial infarction. *JACC Cardiovasc Imaging* 2009; 2:580.

73. Klocke FJ, Baird MG, Lorell BH, et al: ACC/AHA/ASNC guidelines for the clinical use of cardiac radionuclide imaging: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASNC Committee to Revise the 1995 Guidelines for the Clinical Use of Radionuclide Imaging). *Circulation* 2003; 108:1404.

74. Wagner GS, Macfarlane P, Wellens H, et al: AHA/ACCF/HRS recommendations for the standardization and interpretation of the electrocardiogram: Part VI: Acute ischemia/infarction: A scientific statement from the American Heart Association Electrocardiography and Arrhythmias Committee, Council on Clinical Cardiology; the American College of Cardiology Foundation; and the Heart Rhythm Society: Endorsed by the International Society for Computerized Electrocardiology. *Circulation* 2009; 119:e262

75. Giannitsis E, Katus HA: *Biomarkers of necrosis for risk assessment and management of ST-elevation myocardial infarction*. In: Morrow DA, ed. *Cardiovascular Biomarkers: Pathophysiology and Disease Management*, Totowa, NJ: Humana Press; 2006:119-128.

76. Baur LH: Magnetic resonance imaging of persistent myocardial obstruction after myocardial infarction. A tool becoming increasingly important in clinical cardiology?. *Int J Cardiovasc Imaging* 2009; 25:549.

77. Mensah GA, Hand MM, Antman EM, et al: Development of systems of care for ST-elevation myocardial infarction patients: the patient and public perspective. *Circulation* 2007; 116:e33.

78. Moser DK, Kimble LP, Alberts MJ, et al: Reducing delay in seeking treatment by patients with acute coronary syndrome and stroke: A scientific statement from the American Heart Association Council on cardiovascular nursing and stroke council. *Circulation* 2006; 114:168.

79. National Heart Lung and Blood Institute : *Act in Time to Heart Attack Signs*.

80. Morrison LJ, Brooks S, Sawadsky B, et al: Prehospital 12-lead electrocardiography impact on acute myocardial infarction treatment times and mortality: A systematic review. *Acad Emerg Med* 2006; 13:84.

81. Goldstein P, Lapostolle F, Steg G, et al: Lowering mortality in ST-elevation myocardial infarction and non-ST-elevation myocardial infarction: Key prehospital and emergency room treatment strategies. *Eur J Emerg Med* 2009; 16:244

82. Antman EM, Hand M, Armstrong PW, et al: 2007 focused update of the ACC/AHA 2004 guidelines for the management of patients with ST-elevation myocardial infarction: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

83. Hamon M, Agostini D, Le Page O, Riddell JW: Prognostic impact of right ventricular involvement in patients with acute myocardial infarction: meta-analysis. *Crit Care Med* 2008; 36:2023

84. Antman EM, Anbe DT, Armstrong PW, et al: ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction.

85. Van de Werf FJ, Topol EJ, Sobel BE: The impact of fibrinolytic therapy for ST-segment-elevation acute myocardial infarction. *J Thromb Haemost* 2009; 7:14.

86. Kiernan TJ, Gersh BJ: Thrombolysis in acute myocardial infarction: Current status. *Med Clin North Am.* 2007; 91:617.

87. Rakowski T, Dziewierz A, Siudak Z, et al: ST-segment resolution assessed immediately after primary percutaneous coronary intervention correlates with infarct size and left ventricular function in cardiac magnetic resonance at 1-year follow-up. *J Electrocardiol* 2009; 42:152.

88. Rekik S, Mnif S, Sahnoun M, et al: Total absence of ST-segment resolution after failed thrombolysis is correlated with unfavorable short- and long-term outcomes despite successful rescue angioplasty. *J Electrocardiol* 2009; 42:73.

89. Appelbaum E, Kirtane AJ, Clark A, et al: Association of TIMI myocardial perfusion grade and ST-segment resolution with cardiovascular magnetic resonance measures of microvascular obstruction and infarct size following ST-segment elevation myocardial infarction. *J Thromb Thrombolysis* 2009; 27:123

90. Bjorklund E, Jernberg T, Johanson P, et al: Admission N-terminal pro-brain natriuretic peptide and its interaction with admission troponin T and ST-segment resolution for early risk stratification in ST elevation myocardial infarction. *Heart* 2006; 92:735.

91. White HD, Chew DP: Acute myocardial infarction. *Lancet* 2008; 372:570.

92. Huynh T, Perron S, O'Loughlin J, et al: Comparison of primary percutaneous coronary intervention and fibrinolytic therapy in ST-segment-elevation myocardial infarction: bayesian hierarchical meta-analyses of randomized controlled trials and observational studies. *Circulation* 2009; 119:3101.

93. Beygui F, Collet JP, Nagaswami C, et al: Images in cardiovascular medicine. Architecture of intracoronary thrombi in ST-elevation acute myocardial infarction: Time makes the difference. *Circulation* 2006; 113:e21.

94. http://www.csikerala.org/acsregistry.php

PATIENT INFORMATION SHEET

NAME:

AGE/SEX:

OCCUPATION:

ADDRESS:

PHONE NUMBER:

TIME & DATE OF ONSET OF CHEST PAIN:

TIME& DATE OF ADMISSION:

HYPERTENSION (WITH DURATION):

DIABETES (WITH DURATION):

PRIOR HISTORY OF MI:

SMOKING (IN YRS):

ALCOHOLISM (IN YRS):

PAN CHEWING:

GANJA ABUSE:

TUBERCULOSIS:

BRONCHIAL ASTHMA:

CLINICAL EXAMINATION:

CARDIO VASCULAR SYSTEM:

RESPIRATORY SYSTEM:

ABDOMEN:

CNS:

BODY MASS INDEX:

INVESTIGATIONS:

BLOOD SUGAR:

UREA:

CREATININE:

LIPID PROFILE:

CPK:

TROPONIN T:

ECG:

ECHOCARDIOGRAM (1):

ECHOCARDIOGRAM (2):

ABBREVATIONS

CK-MB – Creatine Kinase- (Muscle Brain subunit)

LDL – Low Density Lipoprotein

HDL – High Density Lipoprotein

BMI – Body Mass Index

TGL – Triglycerides

SBP – Systolic Blood Pressure

DBP – Diastolic Blood Pressure

LV – Left Ventricle

EDHF – Endothelial Dependent Relaxing Factor

cGMP – cyclic Guanosine Mono Phosphate.

ET – endothelin

GTP – Guanosine Tri Phosphate

RV – Right Ventricle

ATP – Adenosine Tri Phosphate

NO – Nitric Oxide

ACS – Acute Coronary Syndrome

ECG – Electro cardiogram

ACC/AHA – American Heart Association

COPD – Chronic Obstructive Pulmonary Disease

CCF – Congestive Cardiac Failure

MDCT – Multi Detector Computerized Tomography

MRI – Magnetic Resonance Imaging

PCI – Primary Coronary Intervention

CABG – Coronary Artery Bypass Grafting

STEMI – ST segment Elevation Myocardial Infarction

t-PA – Tissue Plasminogen Activator

PAI – Plasminogen Activator Inhibitor

DNA – Deoxy Ribo Nucleic Acid

RVMI – Right Ventricular Myocardial Infarction

NSAID – Non Steroidal Anti inflammatory Drugs

RAAS – Renin Angiotensin Aldosterone System

SGOT – Serum Glutamate Oxaloacetate Transferase.

ICD – Iso Citrate Dehydrogense

CMR – Cardiac Magnetic Resonance

AV – Atrio Ventricular

UFH – Unfractioned Heparin

LMWH – Low Molecular Weight Heparin

TXA2 – Thromboxane A2

ROC curve – Receiver Operator Characteristic curve.

2D – Two Dimensional

ACE – Angiotensin Converting Enzyme.

s.no	name	age	sex	Ip.no	occupation	sugar	urea	creatinine	cholesterol	TGL	MI type	EF %	SHT	SHT(yrs)	SBP	DBP	DM yrs	diab status	alcohol	trop T levels	smoking	smoking
1	babu	64	m	107439	cooly	112	24	1	168	159	IMMI	32	1	4	154	100	8	1	10	10	20	1
2	ismail	76	m	100920	shop keeper	146	83	0.8	273	153	IWMI	36	1	12	140	90	8	1	8	10	10	1
3	jayaraman	38	m	113210	auto driver	123	84	1	320	157	ALMI	38	0	0	140	90	5	1	0	10	0	0
4	parvathy	65	f	107692	housewife	180	32	1.1	278	297	IWMI	30	1	3	160	100	15	1	0	10	0	0
5	vasu	48	m	102995	autodriver	140	26	0.7	190	219	IPMI	37	1	5	158	30	5	1	7	10	6	1
6	mahaboo jan	65	f	100397	housewife	156	58	1.5	167	208	AWMI	30	1	8	168	100	10	1	0	10	0	0
7	paramasivan	55	m	102022	autodriver	140	39	1.4	247	188	IWMI	38	0	0	138	70	4	1	0	10	0	0
8	sriramulu	70	m	999665	nil	147	40	1.6	216	260	HLMI	40	1	5	150	90	15	1	0	9.56	30	1
9	chitravel	62	m	100490	daily wage	130	61	1	210	159	AWMI	38	1	6	156	90	15	1	7	9.45	10	1
10	velimaran	66	m	101764	watchman	180	48	0.8	169	162	EAWMI	38	0	0	130	80	5	1	0	9.4	0	0
11	pazhani	43	m	999570	autodriver	198	24	0.9	223	119	AWMI	34	1	3	166	108	0	0	20	9.08	25	1
12	munusamy	60	m	112530	watchman	132	72	1.1	127	165	ALMI	39	1	10	168	90	0	0	10	9.07	10	1
13	ravi	50	m	101221	autodriver	150	58	1.5	150	80	IWMI	38	0	0	136	80	3	1	20	8.46	20	1
14	jayaraman	40	m	102598	labourer	160	44	1.1	284	218	AWMI	35	1	3	176	110	5	1	0	8.4	0	0
15	deenadayalan 64	64	m	998387	watchman	98	30	1.1	265	267	ASMI	40	1	20	172	90	0	0	7	8.36	15	1
16	sampath	66	m	101484	watchman	120	38	1.6	190	75	AWMI	39	1	8	158	96	0	0	0	7.9	0	0
17	saravanan	46	m	102890	labourer	136	25	0.8	184	182	EAWMI	37	1	8	130	70	6	1	0	7.9	5	1
18	natarajan	52	m	101223	vendor	150	30	1	301	169	AWMI	36	0	0	140	80	0	0	4	7.9	6	1
19	shafee	72	m	102331	shop keeper	86	42	1.7	378	137	IWMI	40	1	14	170	100	0	0	6	7.7	35	1
20	kathirvel	50	m	101815	autodriver	238	58	1.8	198	189	ASMI	37	0	0	120	70	0	0	7	7.4	0	0
21	sekar	67	m	101975	mason	156	78	0.9	217	178	IPMI	40	1	9	160	90	7	1	8	6.9	0	0
22	ravi	53	m	999570	autodriver	73	60	1.5	140	73	AWMI	40	0	0	100	60	0	0	30	6.89	30	1
23	sekar	50	m	102658	autodriver	165	28	1	213	274	EAWMI	39	1	8	162	80	3	1	8	6.8	10	1
24	saminathan	62	m	100486	autodriver	126	55	0.3	196	168	AWMI	41	1	10	170	110	0	0	0	6.5	25	1
25	selvaraj	74	m	998590	watchman	110	48	1.4	200	288	IPLMI	38	0	0	120	70	8	1	7	5.86	30	1
26	selvaraj	46	m	106840	auto driver	162	24	0.8	140	135	EAWMI	40	1	6	146	100	0	0	20	5.77	5	1
27	gnanavel	36	m	110868	autodriver	113	28	0.8	180	268	AWMI	41	0	0	140	80	0	0	5	5.6	0	0

s.no	name	age	sex	Ip.no	occupation	sugar	urea	creatinine	cholesterol	TGL	MI type	EF %	SHT	SHT(yrs)	SBP	DBP	DM yrs	diab status	alcohol	trop T levels	smoking	smoking
28	chelladurai	37	m	999739	clerk	80	24	0.8	229	329	AWMI	42	0	0	120	80	5	1	8	5.2	7	1
29	suseela	80	f	102008	housewife	146	40	1.8	249	174	IWMI	39	1	10	166	90	5	1	0	5.2	0	0
30	pandiyan	35	m	107036	autodriver	136	26	0.6	186	140	ALMI	41	0	0	120	82	0	0	10	5.08	10	1
31	sankaran	42	m	112032	autodriver	154	63	1.5	298	178	ALMI	38	1	5	150	100	4	1	10	4.65	10	1
32	usha	55	f	111245	housewife	195	24	1.9	185	140	AWMI	40	0	0	100	70	0	0	0	4.56	0	0
33	jabbar	50	m	110835	business	156	30	0.9	200	150	AWMI	42	1	4	166	110	6	1	0	4.3	0	0
34	saminathan	62	m	100774	autodrver	87	53	1.3	216	87	IWMI	54	0	0	110	74	0	0	3	2.78	30	1
35	mathiyazhgan	44	m	110843	autodriver	130	22	0.8	180	180	AWMI	40	1	6	130	90	0	0	10	2.6	9	1
36	natarajan	56	m	112120	autodriver	136	40	1.2	189	264	IWMI	56	0	0	110	80	0	0	0	2.58	0	0
37	sabir	43	m	102186	nil	112	28	1.2	219	163	ASMI	57	0	0	130	60	0	0	5	2.3	0	0
38	subramani	80	m	100478	watchman	167	62	1.2	173	218	IPLMI	49	1	10	120	80	15	1	4	2.1	6	1
39	dhavamani	53	m	101249	autodriver	129	49	0.7	160	155	IWMI	58	1	10	154	100	10	1	30	2.08	0	0
40	syed abdul razak	62	m	998940	nil	80	25	1	171	316	HLMI	52	0	0	134	74	5	1	0	2.06	6	1
41	nagappan	60	m	113320	autodriver	176	70	2.2	215	118	IWMI	45	1	8	160	90	10	1	12	2	10	1
42	Babu	42	m	101307	office clerk	120	30	1.4	159	158	EAWMI	48	0	0	150	96	0	0	10	2	10	1
43	Rajkumar	55	m	101292	autodriver	254	48	1	246	128	IWMI	56	1	7	160	110	5	1	8	1.9	8	1
44	kannan	60	m	100965	watchman	156	29	1	152	114	AWMI	56	1	4	130	96	5	1	30	1.8	30	1
45	mani	50	m	100496	mason	164	49	1.7	183	226	AWMI	52	1	15	150	100	0	0	8	1.8	8	1
46	gopinath	45	m	107023	security	135	36	1	220	106	IPWMI	65	0	0	130	90	6	1	5	0.96	10	1
47	sivakumar	38	m	106967	autodriver	134	32	0.7	187	150	AWMI	60	1	2	154	110	0	0	6	0.65	7	1
48	kuppan	45	m	999747	autodriver	347	22	0.8	210	324	AWMI	62	1	6	148	106	5	1	9	0.256	25	1
49	venkatesan	55	m	112118	cook	145	34	1.3	176	250	ASMI	50	1	4	150	90	6	1	2	0.256	0	0
50	jayakumar	28	m	998351	autodriver	129	35	1	168	118	AWMI	51	0	0	140	100	0	0	6	0.234	20	1

INSTITUTIONAL ETHICAL COMMITTEE
GOVT.KILPAUK MEDICAL COLLEGE,
CHENNAI-10
Ref.No.6206/ME-1/Ethics/2012 Dt:05.07.2012.
CERTIFICATE OF APPROVAL

The Institutional Ethical Committee of Govt Kilpauk Medical College, Chennai reviewed and discussed the application for approval "A Study on Identification of LVEF less than or equal to 40% by troponin T measurement after ST elevation myocardial infarction" submitted by Dr.J.Jeru Santhosh, MD (General Medicine). PG Student, Govt. Royapettah Hospital, Chennai.

The Proposal is APPROVED

The Institutional Ethical Committee expects to be informed about the progress of the study any Adverse Drug Reaction Occurring in the Course of the study any change in the protocol and patient information /informed consent and asks to be provided a copy of the final report.

GOVT. KILPAUK MEDICAL COLLEGE
12 OCT 2012
Kilpauk, Chennai-10.

CHAIRMAN 12/10/12
Ethical Committee
Govt.Kilpauk Medical College.Chennai